A SYNOPSIS OF BIOLOGICAL DATA ON THE SPECIES OF TRICHIUROIDEI

by

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FAO Fisheries Biology Branch

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F O R E W O R D

The information in this synopsis is based on data from many sources, most of them listed in the References; in particular, considerable use was made of the studies by M. Blackburn and M.S. Prabhu.

It has been prepared as part of the work done in the world survey of the living aquatic resources which is being made by the Biology Branch of the Fisheries Division, F.A.O. (For information on the work in the world survey of living aquatic resources, see the attached "Note on the F.A.O. Programme in connection with Living Aquatic Resources, with Special Reference to the compilation of Data on Species of Economic Importance").

It is intended to be an accumulative repository of data on the biology of the Trichiuroidei as the information becomes available.

This is the first draft, in whose completion and revision the co-operation of the Commission for Technical Co-operation in Africa South of the Sahara, Scientific Council for Africa South of the Sahara and biologists of the region is earnestly requested. Criticism and comment on the usefulness of this study will be welcomed.

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1/ The information compiled in this Synopsis refers mainly to the species of Trichiuroidei being commercially exploited as known to the author.

1. IDENTITY

1.1 Taxonomy

- *Definition*

Phylum VERTEBRATA
Subphylum CRANIATA
Class TELEOSTOMI
Order PERCIFORMES
Suborder TRICHIUROIDEI .....

"Fishes with maxillaries fixed to non-protactile premaxillaries. Bases of caudal fin ray not overlapping the hypural. Pectorals placed low". Berg (1947).

Family Trichiuridae .....

"Much compressed, elongate and band-like with tail tapering to a point; no caudal fin; anal reduced to numerous small spines". Munro (1955).

Family Gempylidae .....

"Oblong compressed body with forked caudal fin; finlets behind dorsal and anal". Munro (1955).

- *Description*

Family Trichiuridae .....

Fishes "with a very long, band-shaped body, and with a completely scaleless skin. Sometimes the spinous part of the dorsal fin is not distinct from the soft part, but if they are separated the spinous portion is never the longer. The anal fin has numerous short spines. The caudal fin is either small or is wanting altogether. The pelvic fins are either reduced to a pair of scale-like appendages or are absent. An air blauder is present". Norman and Fraser (1948).

Three genera of this family are of economic significance:

1. Lepidopus Gouan (1770) .....

Fish "with a row of minute teeth on each side of the roof of the mouth. A single dorsal fin extends along the whole of the back, supported by about 100 rays. The anal spines are numerous, but they are very small or hidden beneath the skin. The caudal fin is present, and is forked. The pelvic fins are represented by a pair of scale-like appendages, and are placed behind the pectorals. The coloration of the head and body is uniformly silvery the fins being pale grey, dashed with yellow". Norman and Fraser (1948).

Norman and Fraser (1948) thought that there was only one species of the genus, viz. Lepidopus caudatus, widely distributed in all the warmer seas; however, a second species (L. tenuis) is listed by De Beaufort in De Beaufort and Chapman (1951) for the Indo-Pacific area.

2. Aphanopus Lowe (1839) .....

Fish "easily recognized by its huge eyes, the absence of teeth on the roof of the mouth, the division of the dorsal fin into two nearly equal parts, the absence of pelvic fins, and by the presence of a curious dagger-like spine behind the vent". Norman and Fraser (1948).

3. Trichiurus Linnaeus (1758) .....

Fish with a "body very elongated, band-like, tail tapering to a point. No scales. Cleft of mouth wide. Strong teeth in the jaws; teeth on the palatines, none on the vomer. One single dorsal along the whole back. Anal spines numerous, minute, the first one sometimes somewhat longer, hidden beneath the skin. Ventral absent or present as small winged spines. No caudal". De Beaufort in De Beaufort and Chapman (1951).

Several species are recognized for this genus.

De Beaufort in De Beaufort and Chapman (1951) gives the following key to the Indo-Australian species of Trichiurus:

A. "The distance between the lateral line and the ventral profile at anus much less than twice in its distance from base of dorsal. Ventrals very small, scale-like.

(a) origin of anal below 31st to 33rd dorsal rays ..... 1. T. glossodon

(b) origin of anal below 38th dorsal ray.... 2. T. muticus

B. "The distance between the lateral line and the ventral profile at anus much more than twice in its distance from base of dorsal. No ventrals.

(a) first anal spine well developed, more than half diameter of eye ..... 3. T. savala

(b) first anal spine minute, not longer than following ones:

(1) Height 12.9 - 15.8. Eye 5.8 - 6.6. Pectoral nearly as long as snout. Fangs barbed..... 4. T. haumela

(2) Height 19. Eye 5.5. Pectoral much shorter than snout. Fangs not barbed..... 5. T. auriga."

De Beaufort in De Beaufort and Chapman (1951) wrote the following note concerning the species T. auriga:

"Klunzinger described this species from a single specimen, long 250 mm., and captured in the Red Sea. As far as I know this species has never been mentioned in literature again, excepting M. Weber l.c. who described a specimen from the Timor Sea. Weber's specimen, which I redescribed here, agrees in most points with that of Klunzinger. T. auriga seems to be very closely related to T. haumela, differing by its lesser height, comparatively larger eye, smaller pectorals, and by the absence of barbs on the fangs".

Another species is listed for the Indo-Australian area, and De Beaufort in De Beaufort and Chapman (1951) wrote the following remarks about it:

Trichiurus japonicus - "Recent authors ..... think it possible that japonicus is identical with haumela. Fowler (Hong Kong Naturalist 7, 1936, p.77) distinguishes the two species as follows:

Eye 2 to 2 1/3 in snout, depth 14-18 ..... T. haumela
Eye 2½ in snout, depth 18 1/5 - 18 4/5 ..... T. japonicus.

These indeed are small differences, and only the examination of a large material from many localities will show if these differences are due to variability inside the species, or to the existence of two species or perhaps geographical races".

The other species of the genus are:

Trichiurus lepturus - Species of wide distribution in the Atlantic Ocean, mainly in warm waters.

T. nitens - Found from Southern California to Northern Peru. Found by Hildebrand (1946) to be very close to T. lepturus of the Atlantic, "differing, apparently, only in having a smaller average number of dorsal rays, a somewhat shorter maxillary, and a slightly larger eye in proportion to length of snout".

Family Gempylidae [2/] .....

Fishes "with a moderately long and more or less compressed body, covered with minute scales. The lower jaw projects a little beyond

---

2/ Whitley (1951) indicated that the type of Gempylus, Cuvier(1829) is conspecific with the type of Acinacea, Bory de St. Vincent (1804) and the names Acinacea and Acinaceidae must replace Gempylus and Gempylidae. The classification of Berg (1947) is, however, preferred and used in this synopsis. That author placed Acinaceidae in the synonymy of Gempylidae.

the upper, and there are some strong canine teeth at the front of both jaws. There are no spines on the gill-covers in the adult fish. The dorsal fin is long, with a notch or narrow space separating the front part, which is supported by weak spines, from the soft part, which has a distinct lobe in front. The anal fin is similar to the soft dorsal. The caudal fin is always present, and is forked. The pelvic fins are small and are placed below the pectorals; each fin is supported by a spine and five soft-rays or is reduced to a spine only. An air bladder is usually present". Norman and Fraser (1948).

The following key is given by Grey (1953) to the genera and species of adult Gempylidae:

"1a. Lateral line faint or absent.

2a. Tail keeled; lateral line faint, undulate; dorsal spines 9-12; vertebrae 30-32 ..... 1. Lepidocybium Gill
L. flavobrunneum (Smith)

2b. Tail not keeled; lateral line almost obsolete; dorsal spines 13-15; skin with bony tubercles. 2. Ruvettus Cocco
R. pretiosus Cocco

1b. Lateral line distinct.

3a. Snout and lower jaw without cartilaginous projections; palatine teeth present.

4a. Ventrals normally developed.

5a. Lateral line double.

6a. Upper lateral line running close to dorsal profile, the lower one running along ventral profile; dorsal spines 15-16 ..... 3. Epinnula Poey

7a. Lower lateral line commencing beneath base of dorsal spine; no teeth on vomer .... E. magistralis Poey

7b. The two lateral lines originating together at upper edge of gill-opening, or the lower branching off from the 2nd or 3rd scale of the upper; vomer with 1-3 teeth on each side; vertebrae 31 .....
..... . E. orientalis Gilchrist and von Bonde

8a. Ventral origin behind tip of pectoral .....
... E. orientalis orientalis Gilchrist and von Bonde

8b. Ventral origin beneath middle of pectoral.

9a. Interorbital space wider than diameter of eye; inside of mouth and gill-cover black .....
..... E. orientalis pacifica subsp. nov.

9b Interorbital space narrower than diameter of eye, inside of mouth mostly pale and of gill-cover dusky ... . E. orientalis americana, subsp. nov.

6b. Upper lateral line running close to dorsal profile, the lower one on middle of sides; dorsal spines 17 .... 4. Thyrsitoides Fowler
T. marleyi Fowler

5b. Lateral line single

10a. Lateral line descending abruptly below posterior part of spinous dorsal; dorsal spines 20; vertebrae 37.... ..... 5. Thyrsites Cuvier and Valenciennes
T. atun (Euphrasen)

10b. Lateral line nearly straight; dorsal spines 17 .... 6. Thyrsitops Gill
..... T. lepidopoides (Cuvier and Valenciennes)

4b. Ventrals absent or reduced to a pair of spines

11a. Lateral line double; dorsal spines 17-18; vertebrae 31 ..... 7. Rexea Waite
R. solandri (Cuvier and Valenciennes)

11b. Lateral line single

12a. No large spine preceding anal fin; dorsal spines 18; vertebrae 33 (determined from dissection of a Japanese specimen) ..... 8. Promethichthys Gill
P. prometheus (Cuvier and Valenciennes)

12b. A relatively large free dagger-shaped spine preceding anal fin; dorsal spines 20-21 ... 9. Nealotus Johnson
N. tripes Johnson

3b. Snout and lower jaw with conical cartilaginous processes, those of the lower jaw much the larger; no teeth on palatines.

13a. Lateral line single; dorsal spines 20-21; vertebrae 34. ..... 10. Nesiarchus Johnson
N. nasutus Johnson

13b. Lateral line double.

14a. Descent of lower lateral line abrupt; dorsal spines 18. ..... 11. Mimasea Kamohara
M. taeniosoma Kamohara

14b. Descent of lower lateral line gradual; dorsal spines 19-32; vertebrae 53. 12. Gempylus Cuvier and Valenciennes
G. serpens Cuvier and Valenciennes

1.2 Nomenclature

- *Valid Scientific name*
- *Synonyms*

SPECIES COMMERCIALLY CAUGHT OR OF POTENTIAL ECONOMIC VALUE	
Valid Scientific Name	Synonyms
Family Trichiuridae	
1. Lepidopus tenuis Gunther 1877	Benthodesmus tenuis Goode and Bean 1896
2. L. caudatus (Euphrasen) 1778	Trichiurus gladius Holten 1802
	T. caudatus Euphrasen 1788
	Scarcira argyrea Rafinesque 1810
	Vandellius lusitanicus Schaw 1803
	Lepidopus govanianus Risso 1826
	L. argyreus Cuvier and Valenciennes 1831; Nardo 1840.
	L. lusitanicus Leach-Capello 1867.
	L. ensiformis Bonaparte 1846
	Trichiurus ensiformis Vandelli 1797
	Lepidopus argenteus Moreau 1881; Roule 1919.
	L. peronii Risso 1810
3. Aphanopus carbo Lowe 1839	Aphanopus simonyi Steindachner 1891
4. Trichiurus muticus Gray 1831	
5. T. savala Cuvier 1829	Trichiurus armatus Gray 1831
	T. roelandti Bleeker 1860
	Enchelyopus savala Bleeker 1868
	Lepturus savala Bleeker 1878

(continued)

Valid Scientific Name	Synonyms
6. T. haumela (Forskål) 1775	Clupea haumela Forskål 1775
	Trichiurus lajor Bleeker 1854; Kner 1865-67.
	Enchelyopus haumela Bleeker 1862
7. T. lepturus Linnaeus 1758	
8. T. nitidens Garman 1899	
9. T. japonicus (Schlegel) 1846	Trichiurus lepturis japonicus Schlegel 1846
Family Gempylidae	
1. Ruvettus pretiosus Cocco 1829	Ruvettus tydemani Weber 1913; Jordan and Hubbs 1922-1925; Jordan 1925.
	R. pacificus Jordan and Jordan 1922, 1925
	R. temminckii Cantraine 1833
	Thyrsites pretiosus Günther 1860; Canestrini 1870.
	T. acanthoderma Lowe 1839
	T. scholaris Poey 1854
	Tetragonurus simplex Lowe 1833
2. Thyrsites atun (Euphrasen) 1791	Scomber atun Euphrasen 1791
	Thyrsites altivelis Richardson 1839; 1843.
	T. atun, var. altivelis Richardson, 1849.
	Lucoscombrus atun van der Hoeven 1855
	Thyrsites chilensis Cuvier and Valenciennes 1831.
	Leionura atun Whitley 1951

(continued)

Valid Scientific Name	Synonyms
3. Thyrsitops lepidopoides (Cuvier) 1830	
4. Rexea solandri	Rexea prometheoides (Bleeker) Thyrsites prometheoides Bleeker 1856. T. bengalensis Alcock 1895 Jordanidia solandri (Cuvier and Valenciennes)
5. Promethichthys prometheus (Cuvier and Valenciennes)	

– *Standard common names*
– *Vernacular names*

Scientific Name	Standard Common Name	Vernacular Names	Country
Family Trichiuridae			
1. Lepidopus caudatus	Strumpbandsfisk		Sweden
	Poisson-sabre		France
	Scabbard-fish	Scale-foot	United Kingdom
	Peixe-espada	Espada-branco	Portugal
	Pez sable		Spain
	Pesce sciabola	Pesce bandiera, Pesce sciabola, Pesce fiamma.	Italy
	Pixxixabla		Malta and Gozo
	Spathi		Greece
	Ribbonfish, Kalvis		Union of South Africa
	Peixe Espada	Espada	Madeira Island.
	Lanzon	Espada	Spanish Sahara
	Frostfish	Para	New Zealand
2. Aphanopus carbo	Espada-preto	Espada, Peixe-espada-preto	Portugal
3. Trichiurus muticus		Asp, Hasb, Hasfak, Asbac, Saloo, Nakhooz	Iran
	Churi		Pakistan
	Djogor	Lajur, Ladjur	Indonesia
	Bun-chang-o		Korea
	Nga-than-she mingya		Burma

(continued)

Scientific Name	Standard Common Name	Vernacular Names	Country
4. T. savala	Chandan	Rupa patia, Chaoree muchee.	Pakistan
	Chooree muchee	Chavalai, Matha chavalai (Tamil); Pedda savallu, Yella savallu (Telugu), Thalayan (Malayalam); Toki veketi, Wagti; Ribbon fish; Hairtail.	India " " " " "
	Dâo ngoen		Thailand
	Nga-thanshe mingya		Burma
	Small-headed ribbon-fish.	Savalcya (Sinhalese); Savalai (Tamil).	Ceylon "
	Komu-katjang	Djogor, Lajur, Ladjur Ladjuru, Komu, Romu, Domu.	Indonesia "
5. T. haumela	Churi	Chandan, Rupa patia	Pakistan
	Puttiah	Rupa Patia (Bengali); Pambole (Canarese); Thalayan (Malayalam); Pitiurkti, Pitiwagti, Bala (Marathi); Savalai, Chavalai, Matha chavalai(Tamil); Pedda savallu, Yella savallu, Savallu (Telegu); Kannada (Pambol); Sawala, Baga, Ribbon fish.	India " " " " " " " " " " "
	Large-headed ribbon fish		Ceylon
	Nga-tagoon		Burma
6. T. haumela	Lajur	Djogor, Lajur, Ladjur, Ladjuru, Rotowu, Bilebile. Kiutoto, Parang-parang, Gala-gala, Turaun.	Indonesia " " " "
		Bolungonas, Langkoy, Bolungnas, Pinka, Sokwan, Sambu kot, Tagisang lawin, Spada, Hairtail.	Philippines
	Tai yue	Nga Tai, Paak tai	Hong Kong

(continued)

Scientific Name	Standard Common Name	Vernacular Names	Country
7. T. lepturus	Hair-tail	Silvery hair-tail, Blade fish	United Kingdom
	Lirio	Peixe-espada-lirio	Portugal
	Kurdela baligi		Turkey
	Sable		Spanish Sahara
	Poisson-sabre		Senegal
	Hair-tail	Ribbon-fish	Gold Coast
	Silverfish		Sierra Leone
	Snakefish	Ribbonfish, Bandfish	Union of South Africa.
	Atlantic cutlassfish	Ribbonfish, Hairtail, Sable	United States of America.
	Sable		Cuba
	Tahali		Venezuela
	Ribbonfish	Cutlassfish	British Guiana
	Peixe Espada	Espada	Brazil
	Pez Sable	Sable, Peje Espada	Uruguay
	Pez Sable		Argentina
8. T.nitidens	Pacific cutlassfish		United States of America.
	Liston	Vaina, Machete, Savola	Mexico
9. T. japonicus	Tambukugan		Philippines
	Tachiuwo		Japan
	Kal-tchi		Korea

(continued)

Scientific Name	Standard Common Name.	Vernacular Names	Country
Family Gempylidae			
1. Ruvettus pretiosus	Escolar	Oilfish	United Kingdom
	Escolar		Spain
	Peixe-escolar	Peixe-sabão	Portugal
	Ruvetto		Italy
	Escolar		Canary Is.
	Escolar	Oilfish	Union of South Africa.
	Ruvetto	Oilfish, Castor-oil fish, Ulago.	Philip-pines.
	Baramutsu	Tamakamasu	Japan
	Escolar	Oilfish, Plaintail.	United States of America.
	Enxova	Cavala-africana, Enxovapreta, Pescada-de-Angola, Peixe-prego.	Brazil " " "
2. Thyrsites atun	Barracouta	Couta	Australia
	Barracouta	Manga	New Zealand
3. T. atun	Snoek		Union of South Africa.
	Sierra	Barracuda	Argentina
	Sierra commun	Sierra	Chile
4. T. lepid-opoides	Cavalinha	Carapau, Lanceta	Brazil
	Sierra del sur	Sierra	Chile
	Caballa blanca	Sierra	Uruguay
	Caballa blanca	Sierra	Argentina
5. Rexea solandri	Snake mackerel		Ceylon
	King barracouta	Tasmanian kingfish, Barraconda, Hake	Australia
6. Promethichthys promethous	Kuroshibikmasu	Sumiyaki, Boshu	Japan

1.3 General variability

- Subspecific fragmentation (races, varieties, hybrids)

Family Gempylidae

Thyrsites atun

- Australia

The existence of different populations of Thyrsites atun in Australian waters has been established by Blackburn and Gartner (1954) on the evidence of observations on geographical variation in ecological characters: differences of spawning seasons, size composition of adult stock; and seasonal movements and annual fluctuations, as disclosed by records of catch and fishing effort, indicate the existence of at least four populations and possibly five or more.

The authors definitely established the existence of the following populations: Bass Strait, Eastern Tasmanian, and Eastern Victorian and New South Wales. In the waters of South Australia and Western Australia they indicated the possible existence of one, two or more populations, assuming that probably there are two populations which, although the geographic limits of their distribution are unknown, may be called the South and Western Australian populations. They thought that other populations also might exist in the waters of western Tasmania, northern New South Wales, or the west coast of Western Australia.

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MARINE AREAS

C. 677

GOODE'S SERIES OF BASE MAPS

MARINE AREAS

ALL OCEANS AND SEAS	
INDO-PACIFIC OCEAN	
Northern Pacific	IN
Northwestern Pacific	INW
Northeastern Pacific	INE
Tropical Indo-Pacific	IS
Indian Ocean	ISW
Eastern Pacific	ISE
Central Indo-Pacific	ISEW
ATLANTIC OCEAN	A
Northern Atlantic	AN
Northwestern Atlantic	ANW
Northeastern Atlantic	ANE
Tropical Atlantic	AS
Western Atlantic	ASW
Eastern Atlantic	ASE
POLAR SEAS	P
Northern Polar Basin	PN
'Western' Arctic Ocean [Atlantic side: 140°E - 180° - 60°W]	PNW
'Eastern' Arctic Ocean [Pacific side: 140°E - 0° - 60°W]	PNE
Southern Ocean	PS
'Western' (150°W - 45°W) Seas north of Antarctic Convergence (approx. 60°S)	PSW
'Eastern' (45°W - 150°W) Seas north of Antarctic Convergence	PSE
Antarctic Circumpolar Sea	PSEW

- *Genetic data (chromosome number, protein specificity).*

(No information found).

2. DISTRIBUTION

2.1 Delimitation of the total area of distribution and ecological characterization of this area

Family Trichiuridae .....

Valid Scientific Name	Delimitation of the total area of distribution	
	General Marine Areas 3/	Occurrence
Aphanopus carbo	Eastern Atlantic Ocean (ASE)	Mediterranean Sea, off the coast of Portugal, Madeira and Canary Islands.
Lepidopus tenuis	Indian Ocean, Central Indo-Pacific (ISW,ISEW)	Off North East coast of Africa; off Japan; between Sandwich Islands and Tahiti (?)
L. caudatus	North eastern and Eastern Atlantic Ocean, Central Indo-Pacific Ocean, Western and Eastern seas north of Antarctic Convergence. (ANE, ASE, ISEW, PSW, PSE).	Occasional wanderer into the North-eastern Atlantic waters as far north as the coast of Sweden; southern coast of Portugal; Mediterranean Sea; coast of West Africa as far south as the Cape of Good Hope; coast of New South Wales and Tasmania in Australia; coast of New Zealand.
Trichiurus muticus	Indian Ocean, Central Indo-Pacific Ocean. (ISW, ISEW).	Persian Gulf, coasts of Pakistan, India, Burma, Thailand, Indonesia, (Sarawak?), China(Canton, Chuson, Yangtsekiang) and Korea.

3/ The Marine Areas are outlined in the preceding map.

(continued)

Valid Scientific Name	Delimitation of the total area of distribution	
	General Marine Areas	Occurrence
T. savala	Indian Ocean, Central Indo-Pacific Ocean	Coasts of Pakistan, India (east and west coasts); Reunion and Andamon Is., Ceylon Burma, Thailand, Malaya, Singapore, Indonesia, Sarawak, Australia (Queensland, Northern Territory, North-Western Australia), Philippines, China, Hong Kong.
T. haumela	Indian Ocean, Central Indo-Pacific Ocean.	Red and Arabian Seas; coasts of Pakistan, India (east and west coasts); Ceylon Andaman Is., Burma, Thailand Indonesia, New Guinea, Australia (Queensland), Philippines, China, Hong Kong.
T. lepturus	North-eastern and Eastern Atlantic Oceans, North-western and Western Atlantic Oceans, "Western" Seas north of Antarctic Convergence. (ANE, ASE, ANW, SSW, PSW).	Occasionally found in the North-eastern Atlantic waters as far north as the coast of Norway; southern coasts of England and Ireland, coast of Portugal, Mediterranean Sea, West coast of Africa as far south as the Cape of Good Hope; coast of the United States as far north as Virginia straggling north to Massachusetts; Caribbean Sea, entire coast of eastern South America.
T. nitidens	Eastern Pacific Ocean (ISE)	From the southern coast of California in the United States to the coast of Peru.
T. japonicus	North-western Pacific Ocean, Central Indo-Pacific Ocean (INW, ISEW).	Middle part of Japan southwards along the coasts of China, Hong-Kong, Formosa and northern Philippines.

Family Gempylidae .....

Valid Scientific Name	Delimitation of the total area of distribution	
	General Marine Areas	Occurrence
Promethichthys prometheus	Western and Eastern Atlantic Oceans; North-western Pacific and Central Indo-Pacific Oceans (ASW, ASE, INW, ISEW)	Off Madeira, Azores, Canaries, Bermuda, St. Helena and Ascension Isles, Hawaii, Japan, Philippines and several south Pacific islands.
Ruvettus pretiosus	North-eastern and Eastern Atlantic Oceans, Northwestern and Western Atlantic Oceans, Eastern Pacific and Central Indo-Pacific Oceans, Northwestern Pacific Ocean, "Western" and "Eastern" seas north of Antarctic Convergence (ANE, ASE, ANW, ASW, ISE, ISEW, INW, PSW, PSE).	From Cardiff, Wales in the United Kingdom to Union of South Africa; Mediterranean Sea; Newfoundland to the Caribbean Sea, Coast of Brazil; from California to the Hawaiian Is., South Sea Islands from Paumoton to Nissan of the Charles Hardy Group, Indonesia, New Zealand, Australia, Philippines, Japan.
Thyrsites atun	Eastern Pacific Ocean, "Western" and "Eastern" seas north of Antarctic Convergence, Central Indo-Pacific Ocean. (ISE, PSE, PSE, ISEW).	Coast of Chile from about Valparaiso southwards to Tierra del Fuego; coast of Argentina, Falkland and Tristan da Cunha Is., South-West Africa and Union of South Africa, Australia in Western and South Australia, New South Wales, Victoria and Tasmania, New Zealand.
T. lepidopoides	Western Atlantic Ocean, "Western"Seas north of Antarctic Convergence, Eastern Pacific Ocean (ASW, PSW, ISE).	Off the coasts of South America from the southern coast of Brazil to the coast of Chile as far north as Africa.
Roxea solandri	Indian Ocean, Central Indo-Pacific, "Eastern" seas north of Antarctic Convergence (ISW, ISEW, PSE)	Indian Ocean, coast of Ceylon; in the western Pacific, from Japan to Australia (coasts of New South Wales and Tasmania), New Zealand

For *ecological characterization of the areas* see Figures 3, 4 and 5.

2.2 Differential distribution

- *Areas occupied by eggs, larvae and other junior stages; annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons.*

Family Trichiuridae

Trichiurus savala

India

Chacko (1950) informed on the occurrence of eggs and larvae probably of T. savala from waters around Krusadai Island.

T. haumela

India

Nair (1952) found that although very large schools of the species are found in the waters of Madras, post-larval stages were extremely rare in the plankton and only two specimens were found in plankton collections of the area. That author thought that the rare occurrences were due to the oceanic habits of the species.

Family Gempylidae

(No information found on the species of this family).

- *Areas occupied by adult stages: seasonal and annual variations of these.*

Species	Country and Territories	Areas occupied by Adult stages.
Family Trichiuridae		
Aphanopus carbo	Madeira Is.	Abundant all year around. Nobre (1935).
Lepidopus caudatus	New Zealand	Bay of Plenty and a number of other beaches not specified by Graham (1953)
	Italy	Approaches the coast during the spring, autumn and winter. Palombi and Santarelli (1953).

(continued)

Species	Country and Territories	Areas occupied by Adult stages.
Trichiurus haumela	India	East coast of India in the fishing centres north of Visakhapattinain; southern part of the west coast near Travancore-Cochin and Malabar, and in the northern part near the Konkan, Bombay and Ratnagiri coast. In the south, near Gulf of Maunar and Palk Bay; southern part of the west coast consisting of Travancore-Cochin and Malabar, and in the northern part, that is Konkan, Bombay, and Ratnagiri coasts. Prabhu (1955).
T. savara	India	Coast of Andhra, from Visakhapattinam to Masulipattam on the east coast; in the south near the Gulf of Maunar and Palk Bay; southern part of the west coast consisting of Travancore-Cochin and Malabar, and in the northern part in Konkan Bombay and Ratnagiri coasts. Prabhu (1955).
T. muticus	India	South coast of India near Gulf of Mannar and Palk Bay. Prabhu (1955).
T. lepturus	Africa, Caribbean Sea.	Gold Coast and Angola in the West coast of Africa; Jamaica and French Guiana in the Caribbean Sea.
T. nitidens	Mexico	Pacific coast of Mexico. Berdegue (1956).
T. japonicus	Japan	From middle Japan southward in rather shallow waters. Okada (1955).

(continued)

Species	Country and Territories	Areas occupied by Adult stages
Family Gempylidae		
Ruvettus pretiosus	Cuba	Plentiful in Cuba. Bigelow and Schroeder (1953).
Thyrsites atun		(See 5.2 Fishing areas - *Geographical ranges (latitudes, distances from coast, etc)*
Rexea solandri	Australia	Coast of Tasmania and New South Wales. Roughley (1951).
	New Zealand	Common outside Otago Harbour. Graham (1953).
Promethichthys prometheus	Japan	Rather common on the coast of the middle part of Japan, mainly near Odawara, Kanagawa Prefecture. Okada (1955).
Thyrsitops lepidopodes	Brazil, Uruguay, Argentina and Chile.	Southern Brazil, Uruguay, Argentina and Chile between Talcahuano and Arica.

(For further information see also 5.2 Fishing areas - *Geographical ranges (latitudes, distances from coast, etc).*

2.3 Behaviouristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

Family Gempylidae

Thyrsites atun

Australia

Blackburn and Gartner (1954) summarized the behaviour of the stocks of the species in Australian waters as follows:

> "There are probably five populations in southern coastal waters, which make migrations to certain areas as follows: one in winter and spring to eastern Victoria and southern New South Wales, one from spring to autumn to Bass Strait and its western approaches, one in summer and autumn to eastern Tasmania, one in autumn and winter to South Australia and Western Victoria, and one (possibly not distinct from the previous population) in autumn and winter to the south coast of Western Australia. Spawning and feeding take place in the course of these migrations. Little is known about the populations when they are not migrating, but the three first-mentioned groups all appear to seek the neighbourhood of eastern Bass Strait between the migratory seasons. The fish prefer waters of about 13° - 18°C and tend to vacate areas when they become cooler or warmer than this."

Blackburn (1957) found a close relationship of the movements of the species with availability of food. He found that:

> "when scarcity of 'the species' occurs in summer and autumn in the coastal fishing areas, it may be due to scarcity of Nyctiphanes, forcing the fish to go offshore for this food which is known to be available there".

South Africa

Davies (1954) thought that the behaviour of the species was as follows:

> "the 'species' which arrive in the Walvis Bay - Cape Cross area of S.W. Africa in summer, are in poor condition as a result of recent spawning. They remain in this area most of the summer and, during this time, feed voraciously on pilchards and build up their condition at the same time gonad development takes place. Then in late summer the shoals move south along the coast, reaching St. Helena Bay in early autumn and the Cape in late autumn and winter. They feed actively on pilchards wherever possible on the journey. Then in late winter and early spring they move west from the Cape and out to deeper water where spawning takes place. After spawning the return movement in deeper water back to S.W. Africa takes place".

(For further information on behaviouristic determinants see 3.5 Behaviour - *Migration and local movements*.
For ecological determinants s see figures 3 4 and 5.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

- *Sexuality (hermaphroditism, heterosexuality, intersexuality).*

  Heterosexuality

- *Maturity (age and size).*

Family Trichiuridae

Trichiurus haumela

India

Age - 3 years old. Prabhu (1955).
Size - 47-48 cm. Prabhu (1955).

Philippines

Size - Minimum size at sexual maturity of females (fork length); range 37.0 - 38.9 cms; mean 37.5 cms. Warfel and Manacop (1950).

Family Gempilydae

Thyrsites atun

Age - (No information found)
Size - ± 50 cm. L.C.F. (Length to caudal fork) smallest size. Almost all of 70 cm. or over were found sexually mature. Blackburn and Gartner (1954).

- *Mating (monogamous, polygamous, promiscuous).*

  Polygamous

- *Fertilization (internal, external).*

  External

- *Fecundity*

- *Relation of gonad size and egg number to body size and to age.*

Family Trichiuridae

Trichiurus haumela

- India

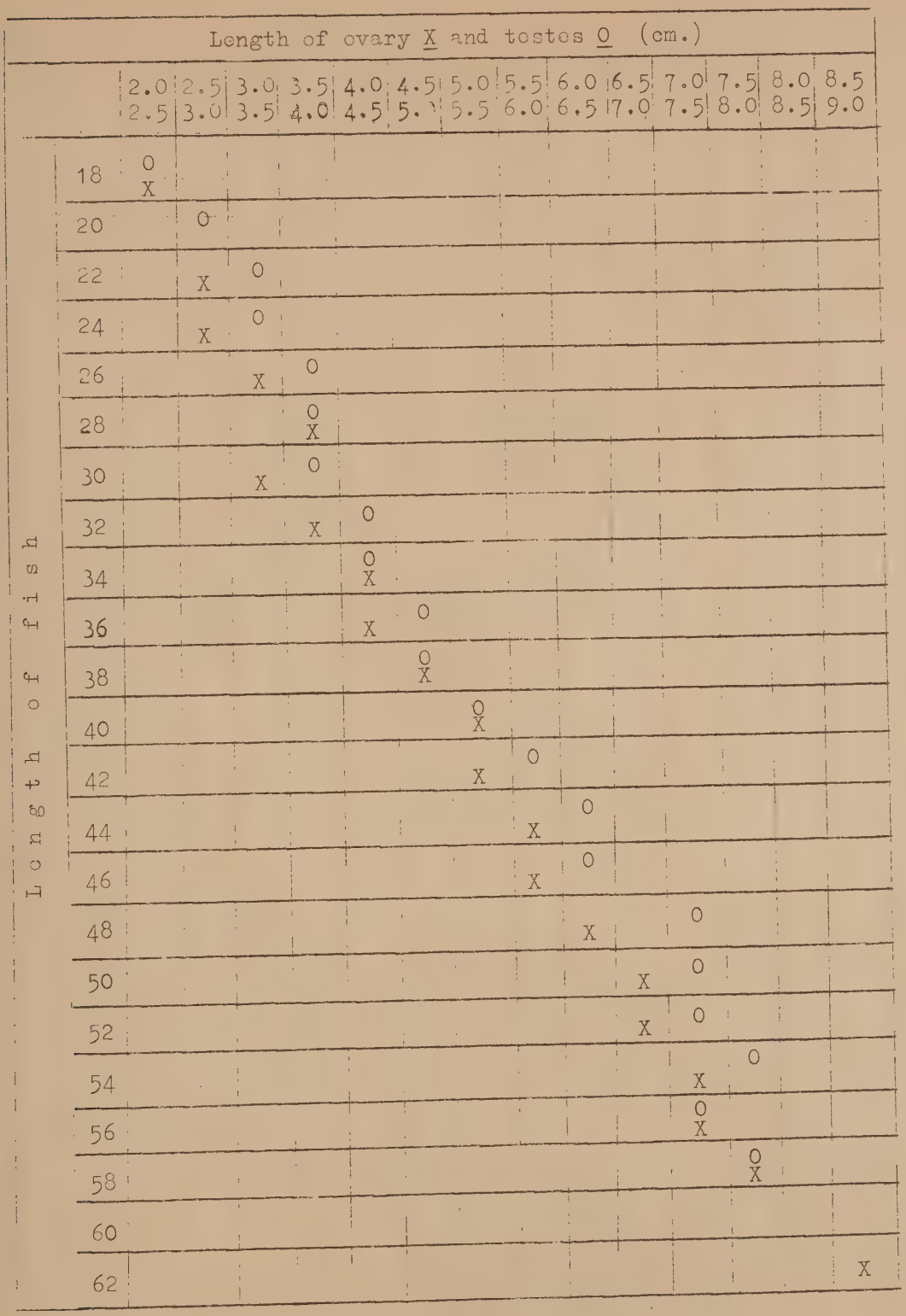
Weight of ovary and fecundity. Prabhu (1955) employed the method of least squares and found that the formula $F = 2526\ W^{1,0308}$ (F and W representing fecundity and weight respectively) best expressed the relation between the weight of the ovary and fecundity, and it showed that the number of eggs produced had a very close correlation with the meanweight of the ovary.

Growth rate of gonads. That same author calculated the relation of the length of the gonads in males and females, even in immature forms, to the length of the fish. He found that the length of the ovary was related to the length of the fish by the equation $Y = 0.6806 + 0.1431X$ and:

> "that for every 10 cm. increase in the length of the fish, the length of the ovary increased approximately by 1.43 cm."

The length of the testes was found to be related to the fish length by the equation $Y = 0.3765 + 0.1465X$, or for every 10 cm. increase of the fish, the length of the testes increased by about 1.47 cm.

In the following table, the approximate values of the observed lengths given by Prabhu (1955) in diagrams, have been plotted.


Length of ovary X and testes O (cm.)
2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5
2.5 3.0 3.5 4.0 4.5 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0
Length of fish
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62

– *Spawning*

– *Spawning seasons (beginning, end, peak).*

Species	Spawning Season: Country	Period	Peak
Family Trichiuridae			
Trichiurus haumela	India (Prabhu 1955)	Probably at end of June (Madras)	
T. lepturus	French Guiana (Puyo, 1949)	August-September	
T. japonicus	Japan (Okada 1955)	August-September	
T. savala	India (Devanesen and Chidambaran 1948)	September-October (?) (Madras)	
Family Gempylidae			
Thyrsites atun	Australia (a) (Eastern and Northern Tasmania, Islands of Bass Strait, Central part of Victorian coast).	Spring, Summer, Autumn.	October-March
	(b) (Eastern coast of Victoria, Southern New South Wales);	Late Autumn to end of Spring.	May-November
	(c) (Western South Australia, Southern Western Australia)	Late Autumn to well into Winter, if not later.	
	(d) (Western Victoria, Eastern South Australia).		Feb-March Apr-Aug.
	(Blackburn and Gartner, 1954).		
	New Zealand (Otago coast) (Graham, 1953)	July	
	Union of South Africa (Davies 1954)	Late Winter and early Spring.	

- *Number of spawnings per year, frequency.*

Family Trichiuridae

Trichiurus haumela -

- India

Jacob (1949) suggested that this species possibly spawned during two seasons or a single one. Prabhu (1955) found that his observations did not support Jacob's suggestions, but indicated instead spawning period restricted to a short anddefinite season once a year.

- *Number of spawnings per year, frequency.*

(No information found).

- *Spawning time of day*

(No information found).

- *Spawning grounds*

- *Coastal (surface, vegetation, shore, shoal, sand, shelter)*

bottom.

- *Oceanic (surface, bottom)*

Species	Spawning grounds
Family Trichiuridae	
Trichiurus haumela	Offshore waters (India).
T. japonicus	Shallow waters close into shore (Japan). (Okada, 1955).
T. lepturus	Estuaries and mouths of rivers (French Guiana) (Puyo, 1949).
Family Gempilydae	
Thyrsites atun	Coastal waters (Australia). (Blackburn, 1957). Probably in an area 50 miles offshore from Cape Point northwards maybe as far as Walvis Bay, (South Africa). (Davies 1954).

- *Egg structure, size, hatching type, parasites and predators.*

Family Trichiuridae 1/

Trichiurus savala

- Indonesia

The eggs of this species are pelagic with a diameter of 2.5 mm., and an oil globule with a diameter of 0.65 mm. Delsman and Hardenberg (1934).

Trichiurus spp.

- Indonesia

The eggs of the species of this genus occurring in the Indo-Pacific area, with the exception of T. savala, are 1,5 to 2,0 mm. in diameter. Delsman and Hardenberg (1934).

Delsman (1929) found that the larvae of the species of Trichiurus may be recognized at once by the very high numbers of myotomes making possible th identification of the eggs. The same author found a caudal migration of the anus towards the tail during the development of larvae of species of that genus.

Trichiurus japonicus

- Japan

Pelagic eggs with a globule and the germinal disc copper-red in colour, and a diameter of 1.35 to 1.80 mm. Okada (1955).

Family Gempylidae

Thyrsites atun

- Union of South Africa

De Jager (1955) gives the following description of the eggs of this species:

> "pelagic, small, spherical, transparent in appearance and contain a single oil globule; the average diameter of fertilized eggs is 0.99 mm. and that of the oil globule 0.26 mm., while the unfertilized egg measures 1.00 mm. with an oil globule of 0.25 mm. diameter. The yolk has a granular appearance and the perivitelline space is small. The egg membrane is thin and has an irregularly cracked surface resembling cell structure".

3/ Delsman (1926) studied six kinds of eggs and larvae of this genus from the Java Sea; unfortunately the author of this synopsis did not have the opportunity of studying Delsman's paper at the time of writing the synopsis.

3.2 Larval history

- *Account of embryonic and juvenile life (prolarva, larva, postlarva, juvenile).*

Family Trichiuridae

Trichiurus japonicus

- Japan

The postlarva, smaller than 10 mm., has a deep body and a large head and does not show the ribbon-like shape of the adult. In larvae longer than 10 mm. the body becomes progressively thinner with marked elongation of the caudal region. Young of 7 to 8 mm. have in front of the dorsal fin a strong spine which gradually disappears. The anal rays are well-developed but later degenerate and become completely concealed by the skin. Okada (1955).

Family Gempylidae

Thyrsites atun

- Union of South Africa

De Jager (1955) carried out successful artificial fertilization of the species and was able to keep the larvae alive for a period of nine days after hatching.

The following tabulated summary drawn by that author shows the development of the embryo up to the stage of hatching.

EMBRYOLOGICAL DEVELOPMENT OF THYRSITES ATUN EGGS KEPT AT AVERAGE TEMPERATURE OF 18.5°C. (DE JAGER, 1955).

Hours after Fertilization	Developmental stage	Remarks
1	Blastodisc	Perivitelline space evident. Eggs float at surface.
2	Two blastomeres	Blastomeres protrude well from yolk sphere.
3	4-8 cell stage	
4	16-32 cell stage	Successful cleavages rhythmical.
5	64-128 cell stage	
6	Blastodermal cap forming.	Cells very small.
11	Blastodermal cap well-formed.	Rounded lenticular dome.
14	Segmentation cavity and early germ ring	Germ ring starts centrifugal growth.

(Continued)

(continued)

Hours after Fertilization	Developmental stage	Remarks
15	Embryonic shield	Germ ring approaching equatorial position
24	Early embryo	Germ ring beyond equatorial position. Blastopore almost closed.
25	Completion of gastrulation	Blastopore closed
26	6 Somite stage	Eyes contain no pupils
27	12 Somite stage	Developing notochord clearly visible
29	36 Somite stage	Embryo encircles major portion of yolk sac
37	Heart formed	Tail coming free from yolk sac
41	Heart starts beating	
46	Advanced stage of embryonic development	Eyes contain pupils. Brain well-advanced. Developing internal ears and pectoral fins visible. Distribution of melanophores easily distinguishable. Eggs now float just below surface of water.
49	Hatching starts	Vigorous tail and body movements rupture egg-shell.
51	General hatching in all containers	Egg capsules sink to bottom upon hatching

De Jager (1955) described the development of the larva up to nine days after hatching summarized below in tabular form.

LARVAL DEVELOPMENT OF THYRSITES ATUN UP TO NINE DAYS AFTER HATCHING.

Hours and days after hatching.	Average Total length (mm.)	Developmental stage
1 hour	2.1	The anterior portion of the larva strongly curved about ovoid yolk sac; head does not extend anterior to yolk sac into which is strongly deflected. Anterio-dorsal profile of head rounded with no indication of mouth or jaws. Body tapers posteriorly with melonophores dorsally distributed in concentrations from behind the eyes towards anal region, two of which are distributed ventrally in the posterior part of the body. Yolk sac extending from past the snout to the rectum which is latter situated in the central part of the body. Fin folds are continuous, the dorsal fold arising just behind the head and continuous about the posterior end of the trunk, extending anteriorly as a ventral fin fold round the yolk sac as far as the anus. Internal ear clearly visible, pectoral fins larger than hitherto.
5 hours	-	No major changes but the body has straightened some, yolk sac slightly smaller, rectum as a straight tube above and behind the yolk sac. The melanophores distributed in seven main concentrations in the body, head extending anteriorly to yolk sac.
1 day	2.9	Reduction of yolk sac resulting in the larva taking up position just below surface of water and becoming more active. Dorsal and ventral fin folds of about equal depth. Notochord extending from posterior portion of brain to end of body and not curved in the caudal region where developing larval rays are beginning to appear as supports of the fin fold. Two-chambered heart apparent.

(continued)

Hours and days after hatching.	Average Total length (mm.)	Developmental stage
2 days	3.1	Head, eyes, heart, gut pectoral fins and internal ears very well developed. Four main concentrations of melanophores, two in the dorsal fin fold, one posteriorly in the ventral fin fold and a fourth situated just anterior to the pectoral fin. A small depression in the profile of the head indicates the development of a stomodaeum. The yolk sac is very small and the larvae approach the voluntary feeding stage which takes place after complete absorption of the yolk at approximately 3-4 days after hatching.
4 days	3.5	Mouth and jaws clearly visible. Fin rays at the tip of the tail more distinct. Larvae float with their heads downward, Movements are much more extensive aided by caudal and pectoral fin movements. Two main concentrations of melanophores are present, one in the dorsal and the other in the ventral fin fold respectively. Marginal pigmentation of eyes begins.
9 days	3.9	Eyes heavily pigmented and jaws strongly developed.

- *Feeding*

Gempylidae

Thyrsites atun

De Jager (1955) tried the following substances as food for larvae of this species reared in glass jars:

(1) nauplius stages of the brine shrimp, Artemia salina;
(2) sea-water containing various diatoms;
(3) minced beef liver pressed through bolting cloth
(4) droplets of human blood.

The first two were indegestible, and the third although successful, fouled the water very rapidly. The last was the most nutritious; the larvae continued to live and grow at a slow rate for nine days with this food, but after that the larvae could not be kept alive with this food because it was not any more sufficiently nourishing.

- *Rates of development and survival.* (See above).
- *Periods of development and survival.* (See above).
- *Parental care.*

  (No information found).

- *Parasites and predators.*

  (No information found).

3.3 Adult history

- *Longevity*

  (No information found).

- *Hardiness*

  (No information found).

- *Competitors*

  (No information found).

- *Predators*

  (No information found).

- *Parasites and diseases*

Family Gempylidae

Thyrsites atun

Parasites: Worms.

3.4 Nutrition and growth

- *Feeding (time, place, manner, season)*

Family Trichiuridae

Trichiurus haumela -

- India

- *Manner*

The species was found by Prabhu (1955) and others to be completely carnivorous and seems to be a selective feeder, not consuming some organisms plentifully available in its feeding grounds. (See *Food (type, volume)*).

- *Season*

Observations were made on materials collected systematically for one year by Prabhu (1955) who found an increase in feeding activity soon after spawning. The following mean monthly average gut contents were found by that author, indicating a high feeding activity from July to February.

Months	Average gut contents 4/ (c.c)
November	5.1
December	9.5
January	5.4
February	5.6
March	2.3
April	2.0
May	1.3
June	1.3
July	4.4
August	5.8
September	5.0
October	5.8

T. savala

Singapore

- *Season*

The observations on seasonal variation in food of this species in the inshore waters of Singapore made by Tham Ah Kow (1950) showed that feeding during the month of January was concentrated on Acetes and Stolephorus larvae, and during March, May, September and December in Stolephorus. Feeding was absent during the remaining months.

4/ The values were read from a histogramm and probably contain a slight deviation from the original figures.

Family Gempylidae

Thyrsites atun

Australia

– *Season*

The seasonal changes in the diets of the species as found by Blackburn (1957) are given in the tables below in percentages of the total stomach contents by each calendar month.5/ (For further identification of the four groups of stomach contents, see *"Food (type, volume)"*).

Southern Victoria 6/												
Stomach Contents	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Percentage											
Nil	57	45	68	70	74	80	89	89	69	86	45	55
Euphausiids	15	51	28	22	10	14	10	1	20	4	14	35
Anchovy	–	–	–	–	6	2	–	8	4	6	32	5
Barracouta (Juvenile)	3	2	–	8	2	1	1	1	–	–	1	–
Other	5	2	4	–	8	3	–	1	7	4	8	5
	Stomachs Examined											
	430	560	443	370	186	588	220	138	364	210	402	679

Northern Tasmania												
Stomach Contents	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Percentage											
Nil	–	–	61	69	–	–	–	–	–	–	77	–
Euphausiids	–	–	36	5	–	–	–	–	–	–	3	–
Anchovy	–	–	1	17	–	–	–	–	–	–	12	–
Barracouta (Juvenile)	–	–	–	5	–	–	–	–	–	–	–	–
Other	–	–	2	4	–	–	–	–	–	–	8	–
	Stomachs Examined											
	–	–	251	905	–	–	–	–	–	–	251	–

5/ See footnote on page 36.

6/ The percentages listed for Southern Victoria and Eastern Tasmania were read from histogramms given by Blackburn (1957) and probably contain a slight deviation from the original figures.

Stomach Contents	Eastern Tasmania											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Percentage											
Nil	25	80	87	74	52	37	-	-	-	-	85	48
Euphausiids	25	11	10	20	40	4	-	-	-	-	14	12
Anchovy	15	-	3	-	2	35	-	-	-	-	1	4
Sprat	15	-	-	-	-	-	-	-	-	-	-	-
Other	20	9	-	6	6	24	-	-	-	-	-	36
	Stomachs Examined											
	226	289	397	318	339	139	x	x	x	x	136	369

x = Number of stomachs which were nil or negligible for certain months.

Stomach Contents	Localities*									
	1	2	2	3	3	4	5	6	7	
	Apr	Mar	April	July	Nov	July Aug.	Mar	Apr	May June July	
	Percentage									
Nil	54	57	54	87	55	44	31	37	68	78
Anchovy	3	-	-	-	-	3	41	6	-	-
Sandy Sprat	-	-	-	-	-	-	25	-	-	-
Pilchard	-	-	-	-	-	3	2	4	19	15
Trachurus	-	-	-	-	22	10	-	-	-	-
Euphausiids	28	35	44	10	-	14	-	44	4	-
Squid	-	-	-	-	-	-	-	1	-	-
Arripis georgianus	-	-	-	-	-	-	-	2	2	-
Others	15	-	-	-	23	26	1	8	7	7
	Stomachs Examined									
	280	86	211	174	40	114	416	209	146	88

* 1. King Islands) King and Furneaux Islands
2. Furneaux Islands)
3. Eden and other places in New South Wales) Eastern Victoria and N.S.Wales
4. Lakes Entrances and other Victorian Localities)
5. Eastern South Australian Waters) South Australia and Western Australia.
6. Western part of South Australia)
7. South coast of Western Australia)

5/ The total number of stomachs examined was 10,181 of specimens caught by normal commercial fishing methods, trolling and pole-fishing, at the surface of the sea, between the end of 1948 and the beginning of 1955. Their sizes ranged from 40 to 116 cm. in length measured from the most anterior part of the head to the caudal fork.

- *Food (type, volume).*

- *Type*

Family Trichiuridae

Trichiurus haumela

- India

Prabhu (1955) analysed the stomach contents of specimens of different sizes caught during a period of one year, and compared them with other sources of food living in the community to see if any selective feeding existed. The results are given in the table below as presented by that author.

Items found in the alimentary tract of T. haumela.	Fishes and other animals caught along with T. haumela
Fishes:	
Hemiramphus spp.	Therapon theraps
Dussumieria spp.	T. puta
Kowala coval	Pelates quadrilineatus
Mugil spp.	Parupeneus spp.
Caranx spp.	Upeneoides spp.
Sardinella spp.	Rastrelliger kanagurta
Leiognathus spp.	Sardinella longiceps
Sciaena spp.	Young ones of Chirocentrus
Therapon spp.	dorab and Cybium spp.
Trichiurus spp.	
Stolephorus spp.	
Crustaceans:	
Penaeus spp.	Nil
Metapenaeus dobsonii	
Acetes spp.	
Others:	
Sepia	Nil
Silicoflagellatae	

That author concluded that although the species is completely carnivorous it shows preference for some types of food, moreover, when the same author found that specimens ranging in size from 17-45 cm. show a tendency to feed on prawns and small-sized fishes such as Stolephorus spp. and Leiognathus spp., although the smaller sized of other species like Parupeneus spp., Upeneoides spp., mackerel, dorab and oil sardine are available. Also fishes of 46-62 cm. feed on fewer prawns and smaller fishes than the young ones.

- *Volume*

Family Trichiuridae

Trichiurus haumela

- India

Prabhu (1955) estimated the rate of feeding of this species from the amount of food left in the gut of specimens caught commercially. He classified the condition of stomach in four categories, depending on the quantity of food in the gut as indicated in the table below.

		Degrees of Feeding Activity
1. Empty	Nil	Nil
2. Almost empty	When the gut contents were less than 4 c.c. in specimens of 30 cm. and above, and when the gut contents were less than 2 c.c. in specimens up to 30 cm. in size.	Slack
3. Partly full	When the gut contents were above 4 c.c. and less than 8 c.c. in specimens above 30 cm. in size, and when the gut contents were 2 c.c. and above and less than 4 c.c. in specimens up to 30 cm. in size.	Active
4. Full	When the gut contents were 8 c.c and above in specimens above 30 cm. in size and when gut contents were 4 c.c. and above in specimens up to 39 cm. in size.	Intense

That author found a 'slack' degree of feeding in individuals ranging in length up to 31 cm., 'slack', 'active' or 'intense' in individuals ranging from 45.1 - 55 cm; 'active' or 'intense' in individuals ranging from 55.1 - 61 cm; 'active' in those above 61 cm.

A certain correlation was found between the volume of feeding and the attainment of maturity. In immature specimens the degree of feeding was found 'slack'; in maturing specimens (47 - 48 cm.) 'slack', 'active' or 'intense', remaining 'intense' up to a size of 61 cm. when it becomes only 'active'.

T. savala

Singapore

Tham Ah Kow (1950) found that in the inshore waters of Singapore this species fed regularly on Stolephorus of different sizes, but was occasionally observed to feed heavily on Mysids, Acetes, small trichiurids and Dussumieria. The following table presented by that author gives details of type and volume of feeding of the species.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Range in length mm.	150 375	-	200 290	-	210 240	-	-	-	340 -	-	-	120 300
No. of specimens examined	36	-	7	-	2	-	-	-	2	-	-	7
Degree of feeding	H	-	H	-	H	-	-	-	M	-	-	H
Food												
Mysids	+	-	-	-	-	-	-	-	-	-	-	-
Acetes	+	-	-	-	-	-	-	-	-	-	-	-
Small Stolephorus	+	-	-	-	+	-	-	-	-	-	-	+
Stolephorus	+	-	+	-	-	-	-	-	-	-	-	-
Trichiurids	+	-	-	-	-	-	-	-	-	-	-	-
Dussumieria	+	-	-	-	-	-	-	-	-	-	-	-

H = Heavy; M = Medium.

That same author classified the species under consideration as a Stolephorus and Zooplankton feeder, indicating as its main food the following organisms: Mysids, Acetes, Stolephorus larvae, Stolephorus and other fish.

Family Gempylidae

Thyrsites atun

- *Type*

- Australia

Blackburn (1957) lists the following organisms as part of the diet of the species in different areas of its distribution.

Common Name	Scientific Name
Euphausiids	Nyctiphanes australis (most common)
	Thysanoessa gregaria
	Nematoscelis megalops or N. difficilis
	Euphausia recurva
	(Probably also other species)
Anchovy	Engraulis australis
Barracouta (Juvenile)	Thyrsites atun
Pilchard	Sardinops neopilchardus
Jack mackerel	Trachurus maccullochi or T. declivis
Squid	Cephalopoda
Australian salmon	Arripis trutta
Sprat	Clupea bassensis
Sandy sprat	Hyperlophus vittatus
Ruff	Arripis georgianus
Other fish	(Not yet identified)
Other crustaceans	(Other than euphausiids, mainly Amphipods, not yet identified).
Fish remains	

- For information on *Food (volume)* see *Feeding (type, place, manner, season)*.

- *Type*

- New Zealand

Graham (1953) found the organisms listed below in the stomachs of this species, on different occasions. He found that the first three had been eaten in enormous numbers.

Common Name	Scientific Name
Pilchard	Sardinops neopilcharda
Sprat	Clupea antipodum
Ahuru	Auchenoceros punctatus
New Zealand sand flaunder	Rhombosolea plebeia
Warehou	Seriolella brama
Blue cod	Parapercis colias
Seaperch	Helicolenus percoides
Sucker fish	Diplocrepis puniceus
Mullet	Agonostomus forsteri (?) Mugil cephalus (?)
Horse mackerel	Trachurus novae-zelandiae
Whalefood	Nyctiphanes australis
Worm	Glycera ovigera
Other Crustaceans	Larvae crustaceans, crabs, shrimps, amphipods.
Squid	Cephalopoda

- *Type*

- Union of South Africa

Common Name	Scientific Name
Pilchard	Sardinops ocellata
Maasbanker	Trachurus trachurus
Round herring	Harengula ovalis (?)
Stockfish (Juvenile)	Merluccius capensis
Anchovy	Engraulis japonicus
Squid	
Harder	Mugilidae
Mackerel	Scomber japonicus
Euphausiid	Nyctiphanes capensis (rare)
Small surface fish	

- Union of South Africa (continued)

The six first organisms appear to be the main food of the species as indicated by De Jager (Personal communication).

- *Type*

- Chile

Bahamonde (1951) studied the stomach contents of 25 specimens of the species in question, from Puerto Montt (July 1949), Calbuco (December 1948, January 1949), and Ancud (February 1949) in Southern Chile and obtained the following preliminary results:

Organisms	Percentage
Euphausiacea	63.93
Munida	.42
Hipperidae	0.25
Nemertinea	0.16
Polychaeta	6.51
Cephalopoda	0.08
Teleostomi	26.54

- *Type*

- Argentina

During the trawling survey on the Patagonian Continental Shelf it was found that the species under consideration fed heavily on Clupea fuegensis and Thysanopsetta naresi, Hart (1946).

- *Type*

- St. Paul and Amsterdam Is.

The species feeds on fish and crustaceans larvae. Ango (1951).

- *Relative and absolute growth patterns and rates.*

- *Relative growth patterns and rates*

(See 4.1 Structure - *Age composition*, Trichiurus haumela)

- *Absolute growth rates*

Absolute Growth Species	Maximum Total Length Observed (cm.)
Family Trichiuridae	
Aphanopus carbo	130
Lepidopus caudatus	200
L. tenuis	80
Trichiurus haumela	100
T. japonicus	150
T. lepturus	150
T. muticus	60
T. nitidens	40
T. savala	100
Family Gempylidae	
Promethichthys prometheus	60
Rexea solandri	80
Ruvettus pretiosus	200
Thyrsites atun	140
Thyrsitops lepidopoides	30

- *Length - Weight relationship*

Family Trichiuridae

Trichiurus haumela

- India

The length - weight relation in the species was calculated by Prabhu (1955) using the equation $W = AL^B$ where W = weight, L = length, A = a constant, and B = exponent usually lying between 2.5 and 4, and found to be 3. for all ideal fish which maintain the same shape.

Measurements were taken of 174 specimens ranging in size from 12 to 56 cm.

The calculated value was $W = 0.0004935\ L^{3.0819}$ inferring that in this species the weight increases proportionately to its length showing a normal pattern.

It was also found that the weight of fishes up to 32 cm. in length increased at a slower rate than in subsequent size groups.

Family Gempylidae

Thyrsites atun

- Argentina

The weight - length coefficient K was calculated by Hart (1946) from the formula

$$K = \frac{W}{L^3} \times 100$$

where W = mean weight in grams and L = mean length in cm.

The values for K averaged 0.380, a figure found high for a species of slender proportions. The extreme range of K observed was 0.320 = 0.449.

- *Relation of growth to feeding, to other activities, and to environmental factors.*

(See *Food (type, volume)*).

3.5 Behaviour

- *Migration and local movements*

Family Trichiuridae

Trichiurus lepturus

- French Guiana

Puyo (1949) stated that this species, although considered a deep water form, has anadromous habits in French Guiana. It migrates into the river mouths and estuaries for spawning, in large schools, during August and September. During the following May the young leave the estuaries for oceanic waters.

Family Gempylidae

Thyrsites atun

- Australia

Tagging of this species was first started in Australia in November 1948, and up to October 1953, 4598 fish had been tagged and released. Only seven tags, 0.15 percent. of the total number released, had been recovered by the beginning of 1954. This was

too small a recovery to help in identifying the number, location and movements of the possible populations of the species. Blackburn and Gartner (1954).

In the table below, the tagging operations in Australia until 1954 are summarized.

SUMMARY OF TAG RELEASES (NUMBER OF RECAPTURES SHOWN IN BRACKETS)
Blackburn and Gartner (1954)

Region of Release 1/	Type of Tags									Total
	White Petersen	Grey Petersen		Body Cavity		Strap	Collar	Hydro-static	Safety pin.	
	Attachment									
	Tail	Tail	Back	Flank	Oper-culum	Back	Tail	Back	Back	
Areas I-IV (Eastern Tasmania)	167	411	245(1)	161	62	-	136	-	76	1258(1)
Area V (Furneaux Is.)	359(1)	10	-	49	50	1	-	-	-	469(1)
Areas VI-VII. (Northern Tasmania)	134	-	-	13	49	34	-	-	-	230
Area VIIA (King I.)	283	13	25	-	30	-	-	1	-	352
Areas IX-XIII. (Southern Victoria)	183(1)	710(4)	-	1070	150	4	-	129	24	2270(5)
Area XIV (Eastern Victoria)	6	-	-	-	-	-	-	-	-	6
Area XV (Southern New South Wales)	13	-	-	-	-	-	-	-	-	13
Total	1145(1)	1144(4)	270(1)	1293	341	39	136	130	100	4598(7)

1/ For detailed description of the areas, see Appendix 1 and figure 1.

Four to five or probably more populations of Thyrsites atun have, however, been identified in Australian waters by different means other than tagging: (1) Bass Strait; (2) Eastern Tasmanian; (3) Eastern Victorian and New South Wales; (4) South Australian, and (5) Western Australian populations. (See 1.3 General variability - *Subspecific fragmentation (races, varieties, hybrids)).*

The following account of the migrations and movements of those five populations was given by Blackburn and Gartner (1954):

"The Bass Strait population appears in early spring at the eastern end of the Strait and moves westward during the spring and summer to the eastern waters of South Australia; it moves back in autumn and disappears towards the eastern waters of Bass Strait in the winter months.

"The eastern Tasmanian population appears in late spring on the northern part of the east coast of Tasmania and moves southwards along this coast during the summer and back in autumn, disappearing in winter in the region from which it came.

"The eastern Victorian-New South Wales population leaves the Furneaux Is. region in late autumn and moves northward along the east coast of the continent to the southern waters of New South Wales and possibly further north during the winter, returning in spring.

"These three populations all appear to begin and end their migrations in the region near the Furneaux Is. (area V). Two of the populations appear to seek this area in winter, the other in summer.

"The South Australian population, although not well-known, probably engages in similar migrations. It first appears in the western waters of South Australia about mid autumn, and seems to move eastward during winter to the western part of the Victorian coast. Nothing is known about return migration but it probably occurs in late winter or spring.

"The Western Australian population may behave in a similar way, perhaps moving westward from the Great Australian Bight in winter and back for the summer, but this is largely surmise."

These authors (l.c.) stated that little is known about vertical movements of the species in Australian waters except that it does occur. The normal fishing practice is based upon the fact that the fish are much easier to find and catch about daybreak, and also at sunset (particularly the former) than during daylight hours. Apparently the fish move to the surface during the night, moving to deeper waters during the day. Specimens have been caught in depths of 100 fathoms.

- Union of South Africa

Marchand (1935) tagged the species off the coast of South West Africa.

The following table taken from De Jager (1955) gives the details of the tagging operation and the results obtained.

MIGRATION OF THYRSITES ATUN. De Jager (1955)

Date of Tagging	Position Tagged	Date of Recovery	Position Recovered
19 Nov 34	Walvis Bay	26 Mar 35	Sandfish Harbour
23 " "	Pelican Point	13 Apr "	Port Nolloth
" " "	Pelican Point	15 " "	Shell Bay, St.Helena Bay
27 " "	South of Pelican Point	25 " "	South of Conception Bay
29 " "	45 miles north of Pelican Point	14 May "	3-4 miles west of Paternoster
16 " "	Pelican Point	4 Jun "	Thorn Bay
29 " "	45 miles north of Pelican Point	17 " "	St. Helena Bay
23 " "	Pelican Point	8 Jan 36	Cape Point
" " "	Pelican Point	13 " "	Conception Bay
29 " "	45 miles north of Pelican Point	16 May "	10 miles west of Cape St. Martin
" " "	45 miles north of Pelican Point	7 Jun "	Buffels Bay, Cape Point
5 Dec "	South of Sandfish Harbour	12 " "	7 miles west of Camps Bay.
16 Nov "	Pelican Point	19 Mar 37	Roman Rock, False Bay
23 " "	Pelican Point	26 Apr "	Bullnose, False Bay
16 " "	Pelican Point	4 May "	Donkin Bay
23 " "	Pelican Point	19 May 38	St. Helena Bay
29 " "	45 miles north of Pelican Point	23 Jun 38	Robben Island

Of 3,755 tagged fish, 17 were recovered. The position of recapture was always south of the position of tagging. It seems to prove that the species migrates southwards from off the South West African coast to the region off the west and south coasts of the Union of South Africa. De Jager (1955).

Davies (1954) gave the following account of the migration and movements of the species in South African waters: the species arrives in the Walvis Bay - Cape Cross area of South West Africa during the summer in poor condition, due to recent spawning. It

remains in this area most of the summer when gonad development takes place. During late summer the shoals move south along the coast, reaching St. Helena Bay in the early autumn and the Cape in the latter part of the same season and winter. In late winter and early spring they move west from the Cape and out to deeper waters for spawning. After spawning the shoals return to South West Africa, moving in deeper waters.

B.v.D. de Jager, Professional Officer of the Division of Fisheries of the Department of Commerce and Industries of the Union of South Africa, has informed the author of this Synopsis that tagging of this species in the St. Helena Bay area will be carried out during the course of 1958.

- New Zealand

Graham (1939) observed that the species occurred on the surface waters in the Otago district from about October to July, disappearing in August and September, probably for spawning purposes, and it is not known where they go. Only a few remain in the Otago region.

- *Schooling*

Family Trichiuridae

Trichiurus haumela, T. savala, T. muticus

In Indian waters each species shoals separately and at different places. Prabhu (1955).

Delsman (1926) observed that at certain periods, mainly at the beginning of the East monsoon, T. haumela approaches the coast in dense shoals and remains in shallow water, disappearing suddenly after a few days.

(See 2.2 Differential distribution).

Family Gempylidae

Thyrsites atun

- New Zealand

Graham (1953) observed large or small shoals of the species up and down the coastline of Otago and in Otago Harbour. That author on occasions observed the species singly or in dense shoals occupying many acres at the surface up to 12 miles off-shore, the number probably depending mainly on availability of food, and water conditions.

- *Reproductive habits*

Family Trichiuridae

Trichiurus lepturus

(See 3.5 Behaviour - *Migration and local movements).*

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) observed that probably the species prefer waters between 12° and 19°, and particularly between 13° and 18°, at least during the spawning season.

- Union of South Africa

Davies (1954) stated that reproduction of the species takes place in deep water.

4. POPULATION (STOCK)

4.1 Structure

- *Sex ratio*

Family Trichiuridae

Trichiurus haumela

- India

The sex ratio of about 1,000 specimens examined by Prabhu (1955) was found to be 3 females to 2 males.

Family Gempylidae

Thirsytes atun

- Australia

The gonads of 9,531 specimens of all sizes were examined by Blackburn and Gartner (1954) and it was found that females were 54.7 percent. and males for 45.3 percent. of the total. An analysis of the numbers at successive lengths showed, however, that the sexes were nearly equal in all sizes up to 70 cm. From 71 cm. upwards the number of females, with one exception, regularly surpassed the number of males on an increasing scale.

- Argentina

(See 4.1 Structure - *Size composition*).

- *Age composition*

Family Trichiuridae

Trichiurus haumela

- India

Since the species is scaleless, Prabhu (1955) studied otoliths and length frequencies to determine the age of the species. That author found that growth rings were present in almost all the otoliths examined including a few of the species T. savala and T. muticus examined for comparison, but the length, width and thickness of the otoliths showed a gradation corresponding with the length of the fishes.

He also found that the rate of increase in length of otoliths in the various size groups was approximately gradual and somewhat proportional to the length of the fish as shown in the following table.

Number of Otoliths Examined and their Average Size in Different Size Groups. Prabhu (1955)

Size groups of specimens (cm.)	Number of otoliths examined.	Average size of the otoliths (mm.)
10-20	11	1.64
20-30	11	2.35
30-40	28	3.13
40-50	37	4.00
50-60	31	4.67
67-60	8	5.90

The distribution of the length frequencies of 1,054 specimens examined by Prabhu (1955) showed at least four distinct modes of the following size groups, probably representing four year classes: 16-20 cm., 28-32 cm., 44-46, 52-56 cm. Considering the mid-point measurements of these four size groups, the average sizes attained by individuals from their first to fourth year of life, it could be assumed that the first-year class specimens attain a length of 18 cm., the second-year class 30 cm., the third-year class 46 cm., and the fourth-year class 54 cm. Since the spawning of the species seems to happen at the end of June and since the first-year class with an average length of 18 cm. is found in large numbers in the month of April, a growth of nearly 18 cm. during the first year seems to take place, followed by a growth of about 12, 16 and 8 cm. during the second, third and fourth years respectively. The higher growth of about 16 cm. during the third year is probably caused by sample bias brought about by the inshore migration of the different size groups. Prabhu (1955).

- Size composition

Family Pempheridae

Pempheris affinis

- Australia

Blackburn and Gartner (1954) made the following observations on the sizes of mature fish of the species in Australian waters:

(1) Victorian fish (Areas X, XI, XII, XIII)[8]

In each of three fishing seasons (1945-46, 1951-52, 1952-53) averaged between 70 and 80 cm. L.C.F. (length to caudal fork). The proportion over 90 cm. was insignificant.

(2) Northern Tasmanian fish (Areas VI, VII, VIII)

In each of three seasons (1947-48, 1948-49, 1952-53) averaged between 70 and 80 cm. The proportion over 90 cm. was insignificant in two seasons but quite substantial in 1948-49.

(3) Eastern Tasmanian fish (Areas I, III)

In each of two fishing seasons (1947-48, 1948-49) averaged between 75 and 85 cm. The proportion over 90 cm. was substantial in both seasons.

- Union of South Africa

In general the average length (length from tip of jaws to the shortest caudal fin rays) of the species caught is 91.7 cm. De Jager (personal communication).

- Argentina

During the trawling surveys on the Patagonian Continental Shelf in the summer and autumn 45 adult specimens of this species were captured, fairly close to the coast in moderately shallow water.

The lengths of these fish were found to be consistent, with the means 97.3 cm. for males (range 87-104 cm.) and 97.8 cm. for females (range 89-112 cm.). Females were found to be more numerous than males, but the number was too small to be considered as a constant feature. No significance could be attached to the slightly greater lengths of the males. Hart (1946).

8/ For definition of the areas see Appendix I and Figure 1.

4.2 Size and density

- *Average size*

Family Trichiuridae

Trichiurus haumela

- Philippines

Warfel and Manacop (1950) found the following size composition in trawl catches in Manila Bay: range 37.9 - 54.6 cm; mean 44.69 cm.

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) studied the seasonal and annual changes of availability of the species in two fishing regions: (1) Victoria, Tasmania and New South Wales; (2) South Australia and Western Australia.

(1) Victoria, Tasmania and New South Wales (Areas I-XV)

The analysis of the average catch per calendar month during the period 1938-39 to 1942-43 in each Victorian area, and for the period 1943-44 to 1946-47 in each Victorian area and in area XV, showed that in areas IX, X, XI and XII there is a spring peak (October-November) and an autumn peak (March-May) in the catch, summer catches being lower and catches in winter (July-September, especially August, generally the poorest month of the year) still much lower.

The analysis of the catch per calendar month for the five-year period 1947-48 to 1951-52 showed the same features.

In areas VI, VII, and VIII the situation was found remarkably similar to the areas above, that is, a yearly spring and autumn peak in the availability of the species, a less productive summer and a very poor winter.

It was concluded that the availability of the species fluctuated in a very similar way in most parts of Bass Strait where it was fished, on the Victorian coast as well as the Tasmanian during 1948-49 to 1951-52.

Little fishing occurs in area XIII. In area XVI there is only one important fishing season with a peak in the winter. In area XV there is a later winter peak and considerable but diminishing captures continue to January.

On the east coast of Tasmania (areas I-IV) the fishing season is almost the same as in Bass Strait, but starts in general later, in late instead of early

spring, and continues until around the end of autumn. There is no evidence of two distinct peaks during a fishing season in areas I-III, but in area IV the earlier peak occurs about December-February and the later one about April-May. The best fishing months in areas I-III are January-March.

No significant information is available from area VIIIB.

(2) South Australia and Western Australia (areas XVI-XIX)

No commercial fisheries take place in these two states and the available information on the distribution of the species is mainly based on observations made from research vessels.

Observations are not available for the months of September, October, November, January and July.

No fish of the species were seen in December. In February and March they were abundant in area XVI, but not seen in area XVII during February and were scarce in March. In April they were rather scarcer in area XVI but plentiful in area XVII. In May area XVI was not examined, but the species was abundant in area XVII.

Only two specimens were taken by research vessels in area XVIII.

In area XIX, as a whole, the species is apparently very rare; it is, however, fairly common from Albany eastwards to Point Culver, where it has been taken in May, June and July.

- *Changes in size* (See *Average size* above).

Family Trichiuridae

Trichiurus haumela

- Philippines

During otter trawl explorations in the Philippines, Warfel and Manacop (1950) caught at different depths various quantities of Trichiurus haumela as indicated in the table under 5.2 Fishing area *Depth ranges*. In Guimaras Strait and vicinities they obtained the results indicated below (in pounds):

6-10 fathoms (8 hrs)	11-15 fathoms (20 hrs)	26-30 fathoms (1 hr)	31-35 fathoms (1 hr)	All depths
3	26	1	885	915

Trichiurus lepturus

- Caribbean

Whiteleather and Brown (1945) during an experimental fishery survey in Trinidad, Tobago and British Guiana obtained the results indicated below, fishing with otter trawls:

Trinidad Area		British Guiana area
Waterloo area	Southwest Gulf of Paria	Off Demerara River
Common	Common	Abundant

The fish caught were young stages.

Family Gempylidae

Thyrsites atun

- Argentina

During the trawling survey of the Patagonian Continental Shelf in which about 150,000 square miles between the Patagonian Coast and the Falkland Islands, and from 44° to 54° were examined, the species was found to be too rare to be considered potentially important. Hart (1946).

This author gave the data contained in the tables below.

OCCURRENCE, RELATIVE NUMBERS AND RELATIVE WEIGHTS OF THE MAIN FISH CATEGORIES IN EACH OF TH THREE REGIONS (North, Intermediate and South)

Main categories of the fish fauna	Frequency of occurrence (% of hauls positive).			% by numbers of each category of totals for each region.			% by weight of each category of total weight for each region		
	North. region	Inter. region	South. region	North. region	Inter. region	South. region	North. region	Inter. region	South. region
Thyrsites	-	-	12.5	-	-	0.82	-	-	5.84

MEAN NUMBERS, MEAN WEIGHTS AND RELATIVE WEIGHTS PER HOUR'S TRAWLING OF THE MAIN CATEGORIES, IN EACH OF THE THREE REGIONS (North, Intermediate and South)

Main categories of fish, extras and rubbish per hour's trawling.	Mean numbers of fish (per hour's trawling)			Mean weight of fish, etc. per hour's trawling (kg.)			% by weight per hour's trawling of fish, extras and rubbish.		
	North. region	Inter. region	South. region	North. region	Inter. region	South. region	North. region	Inter. region	South. region
Thyrsites	-	-	0.73	-	-	2.633	-	-	3.90

- *Changes in density*

(See *Average density* and *Average size*, above).

4.3 Natality and Recruitment

- *Natality*

(No information available).

- *Natality rates*

(No information available).

4.4 Mortality, morbidity

- *Rates of mortality*

(No information available).

- *Factors or conditions affecting mortality*

(No information available)

- *Relation of morbidity to mortality rates*

(No information available)

4.5 Dynamics of population

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) stated that the annual recorded average catch during the decade ending in 1939 and probably during several previous years was about 6,000,000 lb. It fell to about 3,000,000 lb. in 1940, rose to a record height averaging nearly 13,000,000 lb. from 1945-46 to 1948-49, fell to 9,000,000 lb. in 1949-50 and went back during the next two years to about 6,000,000 lb.

Those authors divided the total catches starting in 1947-48 and for two earlier years, 1941-42 and 1942-43, according to populations, referring the catches in areas VI to XII to the Bass Strait population (two thirds or more of the total catch), catches in areas I to IV to the eastern Tasmanian population (almost all the remainder), and catches in areas XIV and XV to the eastern Victorian - New South Wales population (insignificant, but increased in recent years). The very small catches of areas IX were included with the Bass Strait catches.

The great drop in the total catch since 1948-49 was caused almost by a fall in the catch of the Bass Strait population.

The fall in total catch of Bass Strait from 10,400,000 lb in 1948-49 to 6,600,000 lb in 1949-50 was caused by a decline in fishing effort, but the following decline, 3,600,000 lb in 1950-51 and 4,500,000 lb in 1951-52 was due to scarcity of fish in the fishing areas.

Blackburn and Gartner (1954) considered the possible causes of that scarcity such as depletion by overfishing, natural adverse fluctuations in abundance of the entire population, or natural fluctuation in availability of the population to the fishermen, and considered the natural fluctuation in availability of the population (change in behaviour of the fish) as the most probable one.

Blackburn (1957) with available catch and effort data of the species for another two years made a further analysis of the fluctuations in availability of coastal fish.

In the table below catch and effort totals for each of the years for which reliable information was available for fish in the Bass Strait and eastern Tasmanian populations is presented. For practical purposes all catches in areas IX, X, XI and XII on the south coast of Victoria and areas IX, X, XI and XII on the south coast of Victoria and areas VI, VII, and VIII on the north coast of Tasmania are referred to the Bass Strait population and all catches in areas I, II, III and IV to the eastern Tasmanian population.

RECORDED CATCH OF CLEANED HEADLESS FISH (C, in thousands of lb), FISHING EFFORT (E in boat-months), AND CATCH PER UNIT FISHING EFFORT (C/E) FOR DIFFERENT AREAS OF OCCURRENCE OF THE BASS STRAIT AND EASTERN TASMANIAN BARRACOUTA POPULATIONS. BLACKBURN (1957)

(a) Bass Strait *

Year	Area IX +			Areas I, IX, XII +			Areas VI, VII, VIII †			Total		
	C	E	C/E	C	E	C/E	C	E	C/E	C	E	C/E
1947-48	517	?	?	4766	?	?	4217	1160	3.6	9500	?	?
1948-49	440	?	?	4889	1156	4.2	4990	1443	3.5	10318	?	?
1949-50	384	?	?	4082	975	4.2	2210	639	3.5	6675	?	?
1950-51	449	248	1.8	2503	896	2.8	646	360	1.8	3599	1504	2.4
1951-52	543	224	2.4	2885	725	4.0	1088	511	2.1	4516	1460	3.1
1952-53	510	270	1.9	3292	880	3.7	190	148	1.3	3992	1298	3.1
1953-54	122	109	1.1	3454	886	3.9	45	46	1.0	3621	1041	3.5

(b) Eastern Tasmania

Year	Area IV			Areas I, II, III			Total		
	C	E	C/E	C	E	C/E	C	E	C/E
1947-48	358	122	2.9	2487	558	4.5	2845	680	4.1
1948-49	184	122	1.5	2842	518	5.5	3026	640	4.7
1949-50	171	106	1.6	2022	329	6.1	2193	435	5.0
1950-51	367	118	3.1	2204	418	5.3	2571	536	4.8
1951-52	141	123	1.1	1230	411	3.0	1371	534	2.6
1952-53	183	125	1.5	2391	481	5.0	2573	606	4.2
1953-54	58	61	1.0	483	239	2.0	541	300	1.8

* Excluding Victorian areas XIII and XIV and Tasmanian areas V and VIIIA (Fig. 1).

\+ Victorian south coast.

† Tasmanian north coast.

The same author, to obtain more information, divided the annual catch per unit effort records according to the seasons of the year as follows:- summer (December to February), autumn (March to May), winter (June to August) and spring (September to November), and calculated the mean catch per boat-month, a measure of abundance of fish in the fishing areas (available to the fisherman for each quarter for each area or group of areas listed in the table above.

The author, by analysing the data above, summarized his findings as follows:

> " (1) On the south coast of Victoria the mean annual catch per unit of effort of barracouta declined and then recovered over the period 1948-49 to 1953-54, the low point being 1950-51. It did so because catch per unit effort in the autumn quarter of the year, and to a less marked extent in the summer quarter, fluctuated from year to year in that way. These fluctuations were mainly effects of availability, not population size.
>
> " (2) On the north coast of Tasmania the mean annual catch per unit effort declined throughout over the same period, reflecting a decline in the autumn quarter in which effects of availability probably played the main part.
>
> " (3) On the east coast of Tasmania the mean annual catch per unit effort remained fairly stable over the same period until it fell in 1953-54, reflecting a similar trend in summer and autumn. There is evidence that availability effects contributed to this trend, but the possibility of major effects of population size cannot be denied".

4.6 Relation of population to community and ecosystem, biological production, etc.

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) compared monthly changes in total catch and catch per boat of the species in areas III, XI and XV with monthly sea surface temperatures simultaneously recorded in those areas during several years. A correlation between certain temperatures and abundance of the species was established. In area III surface temperatures range from around 13 to 17°C during the period of the year at which the species is caught, and about 10° to 12° in the winter and early spring when the fish are not available or are scarce. In area XI the temperatures range from around 13° to 19° during the fishing season, falling to 12° from July to September when the fish are scarce. In area XV the fishing season is in winter and spring, when the temperature range is from about 12° to 17°; fish are scarce or absent during the summer and autumn when the temperatures are up to 18° to 21°.

Similar correlations were found in other areas suggesting that the fish prefer waters between 12° and 19°, especially 13° and 18°. The different populations during their movements seem to be able to avoid waters warmer than 18° or cooler than 13°, although the fish may support temperatures as high as 19° or as low as 11° as was concluded by the above mentioned authors.

These same authors also concluded that the distribution and abundance of the species is probably more closely related with the physical conditions of the environment, such as temperature and salinity, than with the availability of food. In some instances it was observed that although the proper food was available in a large area, the fish was abundant only at the fringe of such area where the physical conditions were favourable.

The availability (population distribution or behaviour) of the species was though by Blackburn (1957), however, to be closely related to the availability of food. During most of the summer and autumn in the Bass Strait and eastern Tasmania, the species is dependent upon the euphausiid, Nyctiphanes, for most of its food. That author found evidence of a relation between the availability of the species and Nyctiphanes during the season above mentioned in the mean availability (catch per boat - month) of the species and mean percentage of the species stomachs containing Nyctiphanes. He thought that the scarcity of the species during the summer and autumn in coastal fishing areas was probably due to scarcity of that food in coastal waters, making the fish move to offshore waters to find it.

FISHING GEAR (Family Trichiuridae)

Species	Countries and Territories						
	India [14]	Philippines	French Guiana	Madeira Island.	Gold Coast	Italy	Portugal
T. haumela	-	Trawl	-	-	-	-	-
T. haumela	West Coast (1) Via balai (also called Nul balai and Mari balai) (Bag net) [9] (2) Odam vala (also called Peru vala and Paithu vala (Seine net) [10] (3) Thalayan vala [11] (4) Veechu vala (also called Pachuvala and Periyakanmivala) [12]	-	-	-	-	-	-
	East Coast (1) Vella valai (2) Iraga valai (3) Alivi valai (4) Kovallu valai (5) Madi valai (Shore seine) (6) Peria valai (Inshore drag net) [13]	-	-	-	-	-	-
T. lepturus	-	-	Fyke net (Barrières chinoises)	-	Nets (Odume)	-	-
Aphanopus carbo	-	-	-	Long lines	-	-	Long lines
Lepidopus caudatus	-	-	-	-	-	Long lines Seines (Young)	-

- Footnotes to table on page 59.

9/ Length of bag 36'; circumference at mouth 120'; wings 90' x 60'. Size of mesh 3/8" - 7/8" (cotton); ¼ - 2" (coir). Cost 250 Rs. Requires two canoes with a total crew of 10 to 14 men.

10/ Length (a) 40-45'; circumference at mouth 150'; (b) 60-68'; (c) each 160'. Size of mesh (a) 1/5" - ½" (cotton); (b) 8"-9" (cotton); (c) 3" (coir). Cost 150 - 250 Rs. Requires two large canoes and a crew of 14.

11/ Used exclusively for catching the species.

12/ Small meshed cast net operated from a canoe.

13/ Length of bag 21'; net 36'; wings 700'. Breadth or depth: net 36'; wings 45'. Material used: hemp. Cost 350 Rs. Requires one "padagu" and 10 to 15 men.

14/ For further details on description and mode of operation, see *Agricultural marketing in India - Preliminary Guide to Indian Fish, fisheries, methods of fishing and curing. 1951.*

FISHING GEAR (Family Gempylidae)					
	Countries and Territories				
	Australia 15/	New Zealand 16/	Union of S.Africa 17/	Chile 18/	Madeira Is.
Thyrsites atun	Trolling (Moving lures with one or two hooks) Rods	Rods	Trolling (Moving lures)	Trolling (Moving lures)	-
Rexea solandri	Trawlers	Lines Trawlers	-	-	-
Ruvettus pretiosus	Trawlers		-	-	Long lines

15/ In Victoria and New South Wales the lure used is a piece of red or white cloth, or a strip of rawhide, pork rind, or shark skin, lashed to the eye or shank of a large hook. Occasionally two hooks are used, the barb of the leading hook passing through the eye of the second. The lure is attached to a trace wire, from 3 to 6 ft. long, which is in turn fastened, sometimes with a swivel, to a cotton line towed behind the boat. The line may be light, for use near the surface of the water, or weighted with lead to fish further down. Sometimes salted anchovies are thrown over to attract the fish. In Tasmania this method is also used, but most of the fishing there is done with the "jigstick". The lure is a torpedo-shaped piece of wood about 6" long, to which two large barbless hooks are attached. The lure is fastened to a short chain of steel wire with links 4" to 6" long. This leads to the tip of a slender flexible sapling about 8 to 10 feet long, which is the jigstick itself. The tip of the stick is thrust into the water near the stern of the boat and kept rapidly moving there, swiftly swung on board when seized by the fish. Blackburn(1950).

16/ A piece of red-coloured wood - usually cedar - about five to six inches long with a bent nail acting as hook, attached to a stout fishing line about three to four feet long. The line is attached to a slightly curved stick about four feet long, used as a pole. Graham (1953).

17/ The lure is a cigar-shaped lead to which a barbless steel hook of 10/0 size steel hook, three or four thin strips of shark skin or ribbon are attached. It is fastened to a flexible wire, two or three feet long, which is connected by a swivel to a hand line. Biden (1954).

18/ A 15-20 m. long trolling cotton line, the length being determined by the proximity of the fish to the boat, to which a weight - a piece of lead or iron - is fastened at the end to keep the line deep in the water. To the weight are fastened about two m. of wire with a hook. A piece of pig's skin is used as a bait.

Some changes were made in this gear by a FAO expert working in Chile. He used the following gear with good results: a trolling line of cotton, about 20 m. long, having attached at the end a weight of lead or iron of about $\frac{1}{2}$ kg; to the weight two m. of monofilament nylon (No. 100 or 120) were fastened, having a double swivel at the end; to this were tied 0,5 to 0,75 m. of steel wire no. 14; as bait a whalebone jig with double, barbless hooks was used. Whalebone jigs nos. 5 and 6 proved to be the best.

- *Fishing craft*

(See **table on page 62**)

5.2 Fishing areas

- *General geographic distribution*

(See table on page 63).

Species	FISHING CRAFT					
	Countries					
	India	Philippines	Australia	New Zealand	Union of South Africa	Chile
Family Trichiuridae T. haumela	-	Trawler	-	-	-	-
T. haumela T. muticus T. savala	West coast Canoes East coast 'Padagu' 19/	-	-	-	-	-
Family Gempylidae Thyrsites atun	-	-	20 to 40 ft. long sailing vessels, with auxiliary engines. 20/ Crews of 1-3 men.	Motor boats or launches.	30 to 80 ft. long inshore motor boats. 21/	"Bongo" boats and decked motor boats. 22/

19/ Built of planks without frames. Well-suited for the hard surf-knocking.

20/ Usually under sail when fishing, rarely moving faster than 4 knots.

21/ In the Union of South Africa, there are no special boats fishing for the species. The boats fish regularly for other species concentrating in the fisheries of Thyrsites atun during its fishing season.

22/ A "bongo" is a boat with identical bow and stern either about 6 m. long, propelled by oars and sails, or 6.5 to 7.0 m. long with a transom stern where an 8-12 HP outboard motor is affixed.

GENERAL GEOGRAPHIC DISTRIBUTION

Species	Portugal	Italy	Morocco	Madeira Island	Spanish Sahara	French West Africa (Mauritania, Senegal)	Gold Coast	Angola	South-West Africa	Union of South Africa	Cuba	Jamaica	French Guiana	Brazil	Argentina	Chile	Pakistan	India	Ceylon	Burma	Malaya	Thailand	Indonesia	Philippines	Japan	China	Hong Kong	Australia	New Zealand
Family Trichiuridae																													
Aphanopus carbo				x																									
Lepidopus caudatus	x	x	x	x	x	x																							x
Trichiurus haumela																	x	x	x	x	x	x	x	x		x			
T. japonicus																									x		x		
T. lepturus	x	x	x		x	x	x	x				x	x	x			x	x	x	x	x	x	x	x	x	x		x	x
T. muticus																	x	x		x	x	x	x	x		x			
T. savala																	x	x	x	x	x	x	x	x		x			
Family Gempylidae																													
Promethichthys prometheus																									x				
Rexea solandri																												x	x
Ruvettus pretiosus	x	x	x	x	x	x					x																		
Thyrsites atun									x	x					x	x												x	
Thyrsitops lepidopoides															x	x													

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- *Geographical ranges (latitudes, distances from coast, etc.)*

(See figure no. 2).

Family Trichiuridae

Aphanopus carbo

It is a very common species in the Madeira Island waters and is caught by a large number of boats based on Câmara de Lobos, a fishing port west of Funchal.

Lepidopus caudatus

Caught mainly on the Sezimbra coast of Portugal; on the coast of Africa; on the fishing grounds of Madeira, Morocco, Cabo Yubi, in the Spanish Sahara and Cap Blanc on the Mauritania; in Italy the young are caught in coastal sandy bottoms; in New Zealand it is picked up from shores when the fish in various quantities deliberately swim ashore and become stranded.

Trichiurus haumela

On the east coast of India it is caught in large quantities at Madras and in north Andhra, that is, in the fishing centre north of Visakhapattinam; in the southern coast near the Gulf of Maunar and Palk Bay it is caught in very small numbers; in the southern part of west coast, Travancore-Cochin and Malabar, and in the northern part encompassing Konkan, Bombay and Patnagiri coasts is commonly caught. Prabhu (1955). In Ceylon the species is caught in coastal waters and trawling grounds. Munro (1955). Also caught in Taiwan, Philippines and Hong Kong.

Trichiurus japonicus

Caught from middle Japan southwards. Okada (1955); and in Korea.

Trichiurus lepturus

Caught in deep waters on the coast of Portugal and fishing grounds of Morocco, Cabo Yubi in the Spanish Sahara, Cap Blanc on the Mauritania and on the coasts of Senegal; on the Gold Coast is caught in certain parts of the sea near the shore in Ga. Irvine (1947); caught in Angola; in the mouths and estuaries of the rivers of French Guiana it is caught in large quantities. Puyo (1949). Also caught in Brazil.

Trichiurus muticus

On the south coast of India near the Gulf of Mannar and Palk Bay, this species is commonly caught. Prabhu (1955); also caught in Korea.

Trichiurus savala

On the east coast of India this species is commonly caught on the coast of central Andhra, that is, from Visakhapattinam to Masulipattam; caught in very small quantities in the south near the Gulf of Mannar and Palk Bay; it is commonly caught in the southern part of west coast consisting of Travancore-Cochin, Malabar and in the northern part encompassing the Konkan, Bombay and Ratnagiri coasts. Prabhu (1955).

In Ceylon the species is caught in coastal waters, trawling grounds and Gulf of Mancar. Munro (1955).

Family Gempylidae

Promethichthys prometheus

Caught on the middle coast of Japan, mainly near Odawara, Kanagawa Prefecture. Okada (1955).

Rexea solandri

Around seventy years ago it was one of the main commercial species caught in Southern Tasmania where it was abundantly found; to-day it has practically disappeared, being taken only occasionally on the far south coast of New South Wales. Roughley (1951). Graham (1953) names as some of the best fishing localities of New Zealand the north Reef; two-and-a-half to three miles off Otago Heads; Cape Saunders; and between Heyward Point and Otago Heads breakwater, and off Tyrone.

Ruvettus pretiosus

Caught in deep warm waters of the Atlantic Ocean, Mediterranean Sea, Indian and Pacific Oceans.

Thyrsites atun

This species as stated by Blackburn and Gartner (1954) occurs in Australia in neritic waters south of Moreton Bay on the east coast, and Houtman's Abrolhos on the west coast. It is commonly found, however, only on the south coast of the continent and Tasmania. The commercial fisheries are limited in New South Wales to the far southern coast, especially near Eden; in Eastern Victoria there are significant coastal fisheries at Lake Entrance; in Southern Victoria most of the catches are made within 20 miles (generally much less) of the part of the coast from the South Australia border to Wilson's Promontory; in Tasmania the species is commercially caught up to 20 miles (generally much less) from thenorthern coast, and there are important fisheries up to about 10 miles (generally less) from the eastern coast; the species is rarely fished commercially in the waters of King and Furneaux Islands, and there is no commercial fishing for the species in South Australia and Western Australia. Blackburn (1957).

In New Zealand the species is caught at times on the Otago coast.

In South Africa the species is caught during its migration from the Walvis Bay - Cape Cross area in South-West Africa, southwards to the Cape of Good Hope at the Union of South Africa. The fish is caught within a path of 100 miles along the coast, being abundantly found in different points of the coast such as Pelican Point, Port Nolloth and Saldanha Bay, and is very abundant in Table Bay at certain months of the year. The species is caught in Chile between Valparaiso and Puerto Month. Mann (1954); also caught in Argentina.

Thyrsitops lepidopodes

Caught in Chile between Talcahuano and Arica. Mann (1954); also caught in Argentina.

– *Depth ranges*

Family Trichiuridae

In the Philippine waters, Warfel and Manacop (1950) during otter trawl explorations caught species of the family Trichiuridae in depths of 0 to 35 fathoms. The species were mainly caught in depths between 31-35 fathoms as indicated in the table below.

COMPOSITION OF CATCH IN ALL AREAS COMBINED, BY DEPTH OF WATER
Warfel and Manacop (1950)

	0-5 fathoms (11 hrs)	6-10 fathoms (23½ hrs)	11-15 fathoms (54½ hrs)	16-20 fathoms (65½ hrs)	21-25 fathoms (22 hrs)	26-30 fathoms (10 hrs)	31-35 fathoms (12 hrs)	All depths (220 hrs)
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Trichiuridae	19	6	127	471	142	7	885	1,657

Aphanopus carbo

Caught at great depths in Portugal, Madeira Island, and Italy.

Lepidopus caudatus

A species of great depths in Italy. Approaches the coast during certain periods, when it is caught. In New Zealand it casts itself ashore.

Trichiurus haumela

Caught in deep, inshore and brackish waters.

T. japonicus

Caught in rather shallow and inshore waters in Japan.

T. lepturus

Caught in deep, inshore or brackish waters.

T. muticus

Caught in inshore and brackish waters.

T. savala

Caught in deep, coastal or brackish waters.

Family Gempylidae

Promethichthys prometeus

Caught in rather deep waters.

Rexea solandri

Graham (1953) reported that the species was found outside Otago Harbour in New Zealand, schooling at or a little above the bottom from 10 to 20 fathoms in summer months, and from 20 to 120 fathoms in the winter. Occasionally they were caught in three fathoms.

In Australia it is captured in fairly deep waters.

In Ceylon it is found in deep waters off the coast. Munro (1955).

Ruvettus pretiosus

Caught in rather deep waters.

Thyrsites atun

In Australia, New Zealand and South Africa the species is caught at the surface. Tubb (1944) wrote that it appeared that during experimental trawling operations large catches of the species were made in deep water (about 60 to 70 fathoms). These reports at that time had not been confirmed.

Hart (1946) reported that during the trawling surveys on the Patagonian Continental shelf, 45 adult specimens of this species were captured fairly close in to the mainland coast of moderately shallow water.

Often found in Chile at the surface, but more often at depths of 5 to 20 m.

Thyrsitops lepidopoides

Found in Chile at the surface.

5.3 Fishing seasons

- *General pattern of fishing season.*

(See the four next items below).

- *Duration of fishing season*

Family Trichiuridae

Lepidopus caudatus

- Italy

The adults of this species approach the coast during spring, autumn and also during the winter when they are caught. The young are caught during summer in sandy coastal bottoms. Palombi and Santarelli (1953).

Trichiurus haumela, T. muticus, T. savala

- India

On the east coast these three species are fished, from June to February. Fair-sized shoals (3,000 to 5,000 strong) are seen at Tranquebar (Tanjore district) and larger shoals in millions are caught off Mukkur (Ramnad district). Off the west coast, much larger schools of these species occur, from July to November. Davanesen and Chidambaram (1948).

Family Gempylidae

Thyrsites atun

- Australia

The seasons in the different fishing areas of Australia as indicated by Blackburn and Gartner (1954) are indicated below. The fishing areas listed are defined on appendix and figure 1.

(1) New South Wales and Eastern Victoria (Areas XIII, XIV, XV)

There is imp rtant fishing sometimes in early spring, less frequent in the summer, and very infrequent in the autumn in area XIII. Only one important fishing season occurs in area XIV with a peak during the winter (May-July), and occasionally a few fish are caught from November to February. In area XI the peak of the winter season comes a little later and considerable catches are taken diminishing until January.

(2) Southern Victoria (Areas IX, X XI, XII)

There are two peak catches in spring (October-November) and autumn (March-May), and lower catches in the summer and winter (July-September) when they are very low, particularly in August which is generally the poorest month.

(3) Northern Tasmania (Areas VI, VII, VIII)

There are two peak catches in spring and autumn, a decline in the summer, and a minimum in the winter.

(4) Eastern Tasmania (Areas I, II, III, IV)

The season starts in late spring, extending to around the end of autumn.

(5) King and Furneaux Islands, Western Tasmania (Areas VIIIA, V, VIIIB).

Only insignificant catches.

(6) South Australia and Western Australia (Areas XVI, XVII, XVIII, XIX).

No commercial fishing takes place in these areas.

- Union of South Africa

The fishing season starts, as indicated by Davies (1954) when the shoals appear off the West coast near Port Nolloth in April and May, and migrate south to the Cape of Good Hope during June and July.

- South West Africa

The peak of the season is during November, December and January, but may continue on a reduced scale until May. Davies (1954).

- Chile

The fishery is carried out mainly from August to February but it is available at different grades of intensity all year around, along the central and southern coasts.

- *Dates of beginning, peak and end of season.*

Species	FISHING SEASON																													
	Italy		India						Gold Coast		French Guiana		Australia				Union of South Africa		South West Africa				Chile							
			West Coast				East Coast																							
	S*	P*	S		P		S		P		S		S		P		S		P		S		P		S		P			
Family Trichiuridae																														
Lepidopus caudatus	Spring Autumn Winter	-																												
Trichiurus haumela		-	Jul to Nov		-		Jun to Feb																							
T. muticus	-	-	"		-		"																							
T. savala	-	-	"		-		"																							
T. lepturus	-	-	-		-		-				Jan to Apr	-	Aug to Sep																	
Family Gempylidae																														
Thyrsites atun	-	-	-		-		-				-	-	-		Yrly.		Winter Summer Autumn		Apr to Jul		Nov to May		Nov to Jan		Yrly		Aug to Feb			

*S = Seasons. P = Peak.

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- *Variation in time or duration of fishing season*

Family Trichiuridae

Trichiurus haumela, T. muticus, T. savala

- India

From December to March the catches are very poor in the West coast of India. Chidambaram and Venkataraman (1946).

(See *Duration of fishing season*).

- *Factors affecting fishing season*

Family Trichiuridae

Trichiurus haumela, T. muticus, T. savala

- India

The fishery of these species in the west coast is subject to large fluctuations, probably due, to a certain extent, to the availability of food, particularly Stolephorus. Chidambaram and Venkataraman (1946).

Family Gempylidae

Thyrsites atun

- Australia

(See *Relation of population to community and ecosystem, biological production, etc*).

5.4 Fishing operations and results

- *Effort and intensity*

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) recognize four periods in the history of the fisheries of this species in regard to availability of records of catch (beheaded and cleaned fish) and effort as follows:

"(1) 1911 to 1937-38 - Records of total catch by months and areas are available for Victoria, where areas IX (mainly Port Fairy) and XI (mainly Queenscliff) contributed over 80 per cent. of the catch. Records of total catch in Tasmania are only available for a few years and even then are estimates (Blackburn 1950) and are not dissected by months and areas. No records are available for New South Wales but catches are known to have been negligible. There are no good records of fishing effort.

"(2) 1938-39 to 1942-43 - The position is much the same except that the Victorian catches were more evenly distributed along the coast, areas X (mainly Apollo Bay and Lorne) and XII (mainly San Remo) having become important (Blackburn 1950), Tables 3, 4). There are reliable dissected records of Tasmanian catches for two years only. Blackburn (1950).

"(3) 1943-44 to 1946-47 - A significant fishery began in New South Wales and records of total catch by months and areas are available. The position is otherwise unchanged.

"(4) 1947-48 to 1951-52 - Trustworthy records of total catch by months and areas are available in Tasmania, where the practice of reporting catch by weight had almost completely replaced the inconvenient practice of reporting by number of fish. Good records of fishing effort are to hand from Victoria (from 1948-49) and Tasmania, where the number of boats contributing to the barracouta catch of each area in each month was recorded for the first time. There are no such effort records for New South Wales where the fishery had again become unimportant, although dissected records of total catch are available."

Blackburn (1950) gave the table below in which the recorded catches of the species in thousand of pounds is given as well as number of boats, and mean catch per boat for Victorian ports.

Year	Queenscliff			Port Fairy			Lorne			Apollo Bay			Westernport	
	Catch	Boats	Catch per Boat.	Catch	Boats	Catch per Boat.	Catch*	Boats	Catch per Boat.	Catch*	Boats	Catch per Boat.	Catch	Boats
1911	1,572	51	31	532	19	28	–	–	–	–	–	–	1	52
1912	1,435	53	27	858	20	43	–	–	–	–	–	–	5	59
1913	1,469	65	23	860	24	36	–	–	–	–	–	–	12	89
1914	1,198	67	18	787	25	31	–	–	–	–	–	–	18	104
1915	1,512	66	23	883	24	37	–	–	–	–	–	–	34	69
1916-17	1,203	55	22	1,239	40	31	–	–	–	–	–	–	99	66
1917-18	1,110	67	17	761	36	21	–	–	–	–	–	–	93	90
1918-19	918	75	12	1,249	32	39	–	–	–	–	–	–	68	94
1919-20	930	63	15	1,839	38	48	–	–	–	–	–	–	75	99
1920-21	1,193	67	18	1,932	38	51	–	–	–	–	–	–	128	166
1921-22	1,356	75	18	1,628	39	42	–	–	–	–	–	–	98	99
1922-23	1,296	83	16	748	39	19	–	–	–	–	–	–	124	87
1923-24	878	64	14	724	31	23	–	–	–	–	–	–	32	92
1924-25	1,257	67	19	963	30	32	–	–	–	–	–	–	50	89
1925-26	770	72	11	1,469	34	43	–	–	–	–	–	–	78	97
1926-27	1,371	68	20	969	34	28	–	–	–	–	–	–	39	99
1927-28	1,270	70	18	1,300	36	36	–	–	–	–	–	–	137	102
1928-29	481	74	6	650	34	19	–	–	–	–	–	–	48	100
1929-30	840	73	12	1,445	31	47	–	–	–	–	–	–	63	106
1930-31	3,343	69	48	1,383	40	35	–	–	–	–	–	–	160	115
1931-32	2,107	62	34	1,513	41	37	–	–	–	17	6	3	256	119
1932-33	2,436	62	39	1,267	40	32	–	–	–	43	9	5	249	70
1933-34	2,138	55	39	865	38	23	–	–	–	229	7	33	261	104
1934-35	2,258	51	44	1,151	40	29	75	4	19	288	12	24	216	104
1935-36	1,841	52	35	787	40	20	228	15	15	402	14	29	298	95
1936-37	1,937	56	35	1,365	36	38	409	15	27	220	13	17	230	94
1937-38	3,894	52	75	854	38	22	457	14	33	194	13	15	416	99
1938-39	1,212	58	21	684	35	20	1,154	13	89	333	14	24	410	104
1939-40	580	49	12	698	32	22	826	11	75	356	14	25	339	114
1940-41	196	59	3	312	33	9	597	10	60	469	12	39	339	138
1941-42	311	46	7	561	33	17	530	13	46	424	14	30	426	129
1942-43	296	65	5	743	34	22	257	4	64	494	14	35	880	139
1943-44	454	47	10	604	31	19	476	11	43	730	16	46	1,082	126
1944-45	542	50	11	378	33	11	517	21	25	537	14	38	1,148	143
1945-46	1,865	63	30	342	38	9	1,319	25	53	1,032	18	57	1,920	143
1946-47	1,343	68	20	438	35	12	1,018	27	38	1,341	20	67	1,063	155
1947-48	1,186	71	17	421	34	12	1,147	27	42	1,241	19	65	1,008	175

* Earlier figures small and irregular.

The same author (1957) recorded catches of cleaned headless fish, fishing effort, and catch per unit fishing effort for the Bass Strait and Eastern Tasmanian areas (See 4.5 Dynamics of Population).

- *Selectivity*

(Information not found).

- *Catches*

Family Trichiuridae

Trichiurus haumela, T. muticus, T. savala

- India

The catches of these species on the West and East coasts of India are considerable. On the West coast the average yield of T. savala and T. haumela for fifteen years was 34,000 maunds annually. The maximum catch took place in 1930-31 when 91,002 maunds were landed. This bumper catch was followed by intermittent declines until 1934-35, but subsequently there was a recovery of the fishery. Devanesen and Chidambaram (1948).

On the East Coast where the three species are caught, the fishery is more important. The maximum catch was made in 1935-36 when 1,17,971 maunds were landed. Devanesen and Chidambaram (1948).

The figures below were given by the above mentioned authors for both coasts:

Years	Month in which they were abundant.	Weight in Maunds*
West Coast		
1929-30	October	24,817
1930-31	July	91,002
1931-32	June	12,294
1932-33	October-November	88,511
1933-34	August-September	879
1934-35	August	1,860
1935-36	October	31,003
1936-37	September-October	71,764
1937-38	October-November	46,761
1938-39	October	10,643
	Average:	37 953
East Coast		
1934-35	August, September and October	65,286
1935-36	July, August and September	1,17,971
1936-37	August and September	75,452
1937-38	July, August and September	78,987
1938-39	June	83,525
	Average:	84,422

* One maund = 37,324 kgs.

Landings of Trichiurus spp. in India during the period 1950-54 are indicated in the table below:

LANDINGS OF TRICHIURUS IN INDIA.	Indian Journal of Fisheries (1956)				
Names of Zones	Landings in Tons				
	1950	1951	1952	1953	1954
1. West Bengal and Orissa	-	52	68	73	148
2. Andhra coast (south of Gopalpur to north of Visakhapatnam).	1,028	679	786	788	217
3. Andhra coast (Visakhapatnam to Masulipatnam).	1,201	274	258	352	77
4. Andhra coast (south of Masulipatnam to north of Pulicut Lake)	141	141	141	141	944
5. Coromandel coast (Pulicut Lake to Cuddalore)	2,918	272	149	2,052	868
6. Coromandel coast (south of Cuddalore to Devipatnam)	124	106	149	126	205
7. Palk Bay and Gulf of Mannar (south of Devipatnam to north of Cape Comorin)	-	159	5,205	1	1,914
8. Travancore-Cochin (Cape Comorin to Ponnani River)	-	10,063	25,075	22,895	11,062
9. Malabar and South Kanara (north of Ponnani River to Mangalore)	5,926	2,352	335	139	56
10. Konkan coast (north of Mangalore to south of Ratnagiri)	529	124	26	72	141
11. Bombay and Gujarat coasts (Ratnagiri to Broach)	5,955	2,456	2,912	28,770	13,267
12. Kathiawar coast	-	-	-	-	190
Total:	17,822	16,678	35,104	55,409	29,089

The percentage of Trichiurus spp. of the landings in India during the period 1950-54 was the following:

1950	1951	1952	1953	1954
3.12	3.17	6.75	9.68	5.02

In the table below, the landings of different species of the family Trichiuridae in different countries is given.

LANDINGS OF TRICHIURUS spp.
FAO Yearbook of Fisheries Statistics (1954-55)

Country and Territories	Landings in thousand metric tons									Species
	1938	1949	1950	1951	1952	1953	1954	1955	1956	
Angola	ø	1.5	-	-	0.6	0.6	0.7	0.8	-	Trichiurus lepturus
Hong Kong	-	0.9	-	-	1.3	1.2	1.1	1.3	-	T. haumela
India	-	-	18.1	16.9	35.7	56.3	29.6	36.7	24.5	T. haumela T. savala
Japan	-	-	-	-	-	17.5	18.2	23.4	-	T. japonicus
Korea(South)	26.7	29.5	-	-	27.4	22.7	28.2	25.2	--	T. muticus T. japonicus
Portugal	2.2	3.1	-	-	3.9	3.8	3.7	4.0	-	T. lepturus
Taiwan	-	-	-	-	1.5	1.7	2.0	3.6	-	Trichiurus spp.

Family Gempylidae

Thyrsites atun

- Australia

Blackburn and Gartner (1954) presented the following table in which the recorded catches of the species for each of the three Australian States in which there is a fishery are given. The figures are for weight of fish with head and viscera removed, which is normally about 70 per cent. of the rounded weight.

RECORDED CATCHES OF CLEANED HEADLESS BARRACOUTA IN AUSTRALIA (LB)
Blackburn and Gartner (1954)

Year	Victoria	Tasmania	New South Wales	All States
1911	2,377,685			
1912	2,656,351			
1913	2,748,671			
1914	2,485,877			
1915	2,845,558			
1916	3,738,277			
1917	2,532,566			
1918	3,115,365			
1919	2,965,486			
1920	3,549,498			
1921	3,974,757			
1922	2,901,230			
1923	1,879,189	2,947,012	-	4,826,201
1924	2,450,904			
1925	2,954,483			
1926	2,117,567			
1927	3,270,934			
1928	2,544,877			
1929	1,779,027	2,977,361	-	4,756,388
1930	4,217,609			
1931	5,056,510	1,360,250	-	6,416,760
1932	4,047,050	903,617	-	4,950,667
1933	4,461,435			
1934	4,517,869	1,693,670	-	6,211,539
1935	4,138,408	1,413,943	-	5,552,351
1936	4,073,884	1,498,892	-	5,572,866
1937	5,281,305	1,637,377	-	6,918,682
1938	5,487,941	1,888,357	-	7,376,298
1939	3,673,787	702,655	-	4,376,442
1940	2,439,852	277,769	-	2,717,621
1941	2,611,064			
1941-42	2,515,660	1,798,041	-	4,313,701
1942-43	2,873,809	2,444,911	-	5,318,720
1943-44	3,745,410	3,084,414	505,303	7,335,127
1944-45	3,558,215	5,803,932	881,281	10,243,428
1945-46	7,347,308	6,116,652	609,130	14,073,090
1946-47	5,856,134	4,568,070	118,712	10,542,916
1947-48	5,522,357	7,070,308	70,927	12,663,592
1948-49	5,541,472	8,032,459	91,508	13,665,439
1949-50	4,627,342	4,411,255	9,396	9,047,993
1950-51	3,221,572	3,221,510	20,896	6,463,978
1951-52	3,673,765	2,487,063	76,566	6,237,394

- Chile

The landings of the species and Thyrsitops lepidopodes in Chile since 1930 are shown in the table below (in thousand metric tons). FAO Yearbook of Fisheries Statistics 1952-53, and 1954-55.

Year	Thousand Metric tons	Year	Thousand Metric tons	Year	Thousand Metric tons
1930	1.1	1940	5.9	1950	5.8
1931	0.5	1941	3.6	1951	4.9
1932	1.1	1942	2.2	1952	4.6
1933	2.1	1943	3.7	1953	5.5
1934	1.8	1944	2.7	1954	9.6
1935	1.6	1945	2.6	1955	17.3
1936	1.7	1946	2.2		
1937	2.0	1947	3.1		
1938	3.9	1948	4.3		
1939	2.9	1949	4.9		

The landings for the different countries in which the species is commercially caught are shown in the table below (in thousand metric tons). FAO Yearbook of Fisheries Statistics 1954-55. (For Chile, see table above).

Countries and Territories	1938	1948	1952	1953	1954	1955
South West Africa	1.4	3.5	2.2	1.7	1.8	2.1
Union of South Africa	7.0	10.9	12.7	12.7	13.2	13.6
Australia	-	-	4.5	4.3	2.4	2.6
New Zealand	0.2	0.7	0.3	0.3	0.2	0.2

5.5 Fisheries regulations

(Information not found).

5.6 Fishing farming, transplanting and other intervention

(Information not found).

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Appendix 1.

AREAS IN AUSTRALIA

Tasmania

Area I	South East Cape to Pittwater
Area II	Pittwater to Cape Bernier
Area III	Cape Bernier to Cape Lodi
Area IV	Cape Lodi to Cape Portland
Area V	Furneaux Is.
Area VI	Cape Portland to Badger Head
Area VII	Badger Head to Table Cape (includes Wynyard)
Area VII	Table Cape to Cape Grim
Area VIIIA	King I.
Area VIIIB	Cape Grim to South East Cape

Victoria

Area IX	South Australian border to Cape Otway
Area X	Cape Otway to Split Point
Area XI	Split Point to Cape Schanck (includes Port Phillip Bay)
Area XII	Cape Schanck to Wilson's Promontory
Area XIII	Wilson's Promontory to Shallow Inlet
Area XIV	Shallow Inlet to New South Wales border

New South Wales

Area XV	New South Wales, all waters; but especially within 100 miles of the Victorian border, where the species is most common.

South Australia and Western Australia

Area XVI	Victorian border to long. 137° 30'E.
Area XVII	Long. 137° 30E. to Cape Adieu
Area XVIII	Cape Adieu to Point Culver
Area XIX	Point Culver to Albany

AREAS OF AUSTRALIA

GOODE'S SERIES OF BASE MAPS
HENRY M. LEPPARD, EDITOR

Fig. 1

71.706

FISHING AREAS FAMILY GEMPYLIDAE

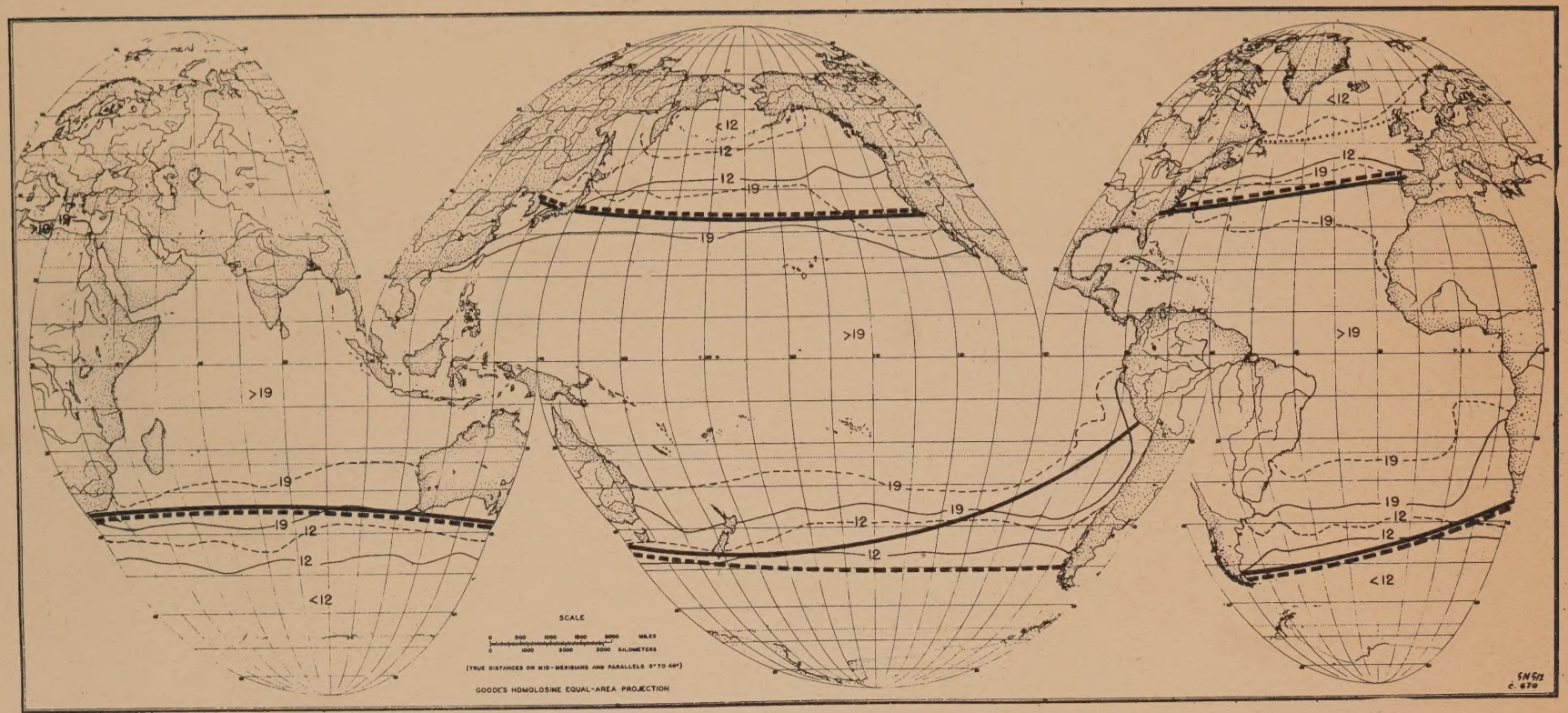
FISHING AREAS - FAMILY TRICHIURIDAE

Fig. 2

SURFACE ISOTHERMS

12° C and 19° C – February and August

Fig. 3



GOODE'S SERIES OF BASE MAPS
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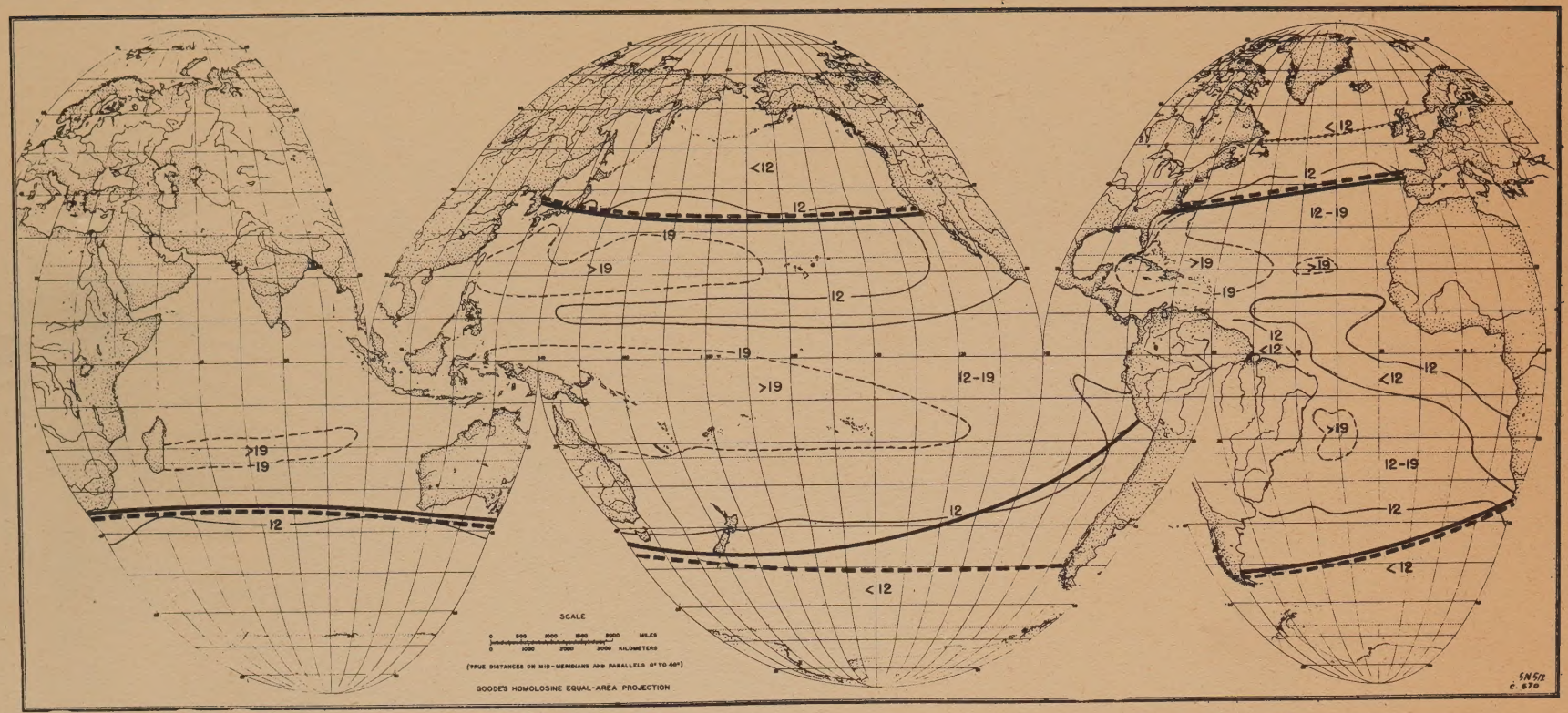
——— February
- - - - August

▬▬ General distribution of the Family Trichiuridae
▬ ▬ " " " " " Gempylidae
..... Stragglers

ISOTHERMS
in 200 m. Depth – 12°C and 19°C

Fig-4



GOODE'S SERIES OF BASE MAPS
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——— 12° C
– – – – 19° C

General distribution of the Family Trichiuridae
" " " " " Gempylidae
..... Stragglers